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INDEX

Planigraphy of the temporal bone. By *Johannes Zimmer* 419
Roentgen examination of the temporal bone for cholesteatoma. By *Th. Rosendal* and *H. Ewertsen* 431
Infundibulum of the patent ductus arteriosus studied by thoracic aortography. By *Gunnar Jönsson* and *Georg-Fredrik Saltzman* 445
A new method of bronchography with water soluble contrast. By *Björn E. W. Nordenström* 452
The installation of Co^{60} in a gamma ray beam unit. By *Hazel Merewether*, *S. B. Osborn* and *S. J. Wyard* 459
The risk involved by biopsy in breast cancer. By *Sigvard Kaae* . . . 469
Cytological changes in vaginal smears in radium and roentgen irradiation of uterine carcinoma and their prognostic significance. Preliminary report. By *Anna Margrethe Nielsen* 479
The demonstration of cancer cells in the urine as a diagnostic aid. By *Carl Deden* 487
Osteochondrosis dissecans in two brothers. The pre- and developed state. By *Hans Novotny* 493
Book reviews 498
Corrigendum ad A grid ionization chamber of special design for the measurement of soft radiations. By *A. Somerwil* 502

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EDITA IUSSU SOCIETATUM RADIOLOGICARUM
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PLANIGRAPHY OF THE TEMPORAL BONE

by

Johannes Zimmer

Planigraphy of the temporal bone as an aid in demonstrating or excluding cholesteatomata in chronic middle ear infections is described with a certain degree of enthusiasm in the somewhat scanty literature on the subject. Planigraphy of the temporal bone is also recommended in cases of tumours arising from the acoustic nerve, erosions of the facial nerve canal, affections of the labyrinth, abnormalities of the external auditory meatus and in order to demonstrate anatomic conditions before radical mastoidectomy is performed. The roentgenologic diagnosis of cholesteatoma in chronic middle ear infection is often very difficult. As WELIN emphasizes, the final diagnosis will depend to a certain degree on the experience of the roentgenologist, because the borderline between normal and abnormal signs is not always obvious or *measurable*. In the case of a sclerotic, poorly- or unpneumatized, temporal bone, a large antrum and broad aditus ad antrum do not always denote the presence of a cholesteatoma.

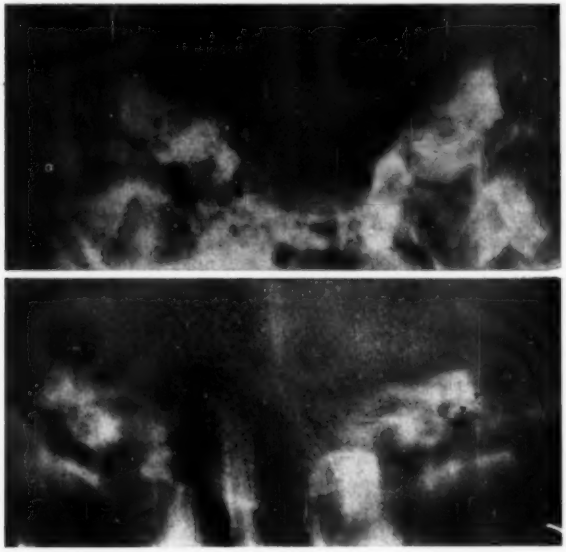
The maximum measurements for the normal antrum as calculated in the fronto-occipital view (10 to 11 millimetres for the vertical and about 6 millimetres for the transverse diameter) may even be sometimes exceeded. For details of these measurements the reader is referred to the communications of MAC MILLAN and, more recently, WALTNER.

In the Altschul (or Towne's) *fronto-occipital* projection the normal antrum is usually cone-shaped towards the aditus ad antrum but if containing a cholesteatoma is often rounded and wider at the base.

In Fig. 1 a the shape of the normal antrum is shown. Fig. 1 b is from an adult (*Case 1*) with 14 years history of discharge where antrum towards the aditus is broad and rounded. Operation: Cholesteatoma of antrum.

From the Department of Radiology (Director: Professor TORLEIF DALE), University Hospital, Oslo, Norway.

Read before the XVII Congress of the Northern Association for Medical Radiology, Aarhus, June 1951; submitted for publication, Oct. 4, 1951.



a

b

Fig. 1.

a. Fronto-occipital view. Normal right antrum in adult; cone-shaped towards the aditus ad antrum. Poor pneumatization. Measurements of antrum — vertical 10 mm, transverse 6 mm — are close to upper normal limits.

b. Planigram (Case 1); fronto-occipital view of enlarged antrum due to cholesteatoma of antrum. Note broad, rounded antrum towards the aditus.

An. = antrum. At. = attic. E. A. M. external auditory meatus.

In the fronto-occipital view, however, the size and shape of the antrum (and aditus) may be difficult to de monstrate with certainty because of the superimposition of certain structures (grooves, emissary veins, linear shadows). This is not always overcome by use of stereoscopy. Thus this important diagnostic sign is often masked. By means of planigraphy, however, it is possible to demonstrate the size and shape of the antrum. If the aditus ad antrum and the attic region be pathologically enlarged the changes may sometimes be revealed in the planigrams obtained in the fronto-occipital projection.

Fig. 2 is from an adult case (*Case 2*) with 3 years history of discharge from right ear, not cholesteatomatous on inspection. In the planigrams, a sharply defined and widened antrum and aditus (b), as well as erosion of roof of attic (c) is shown. Operation revealed cholesteatoma of antrum, aditus and attic, also erosion of tegmen antri (not demonstrable in the films).

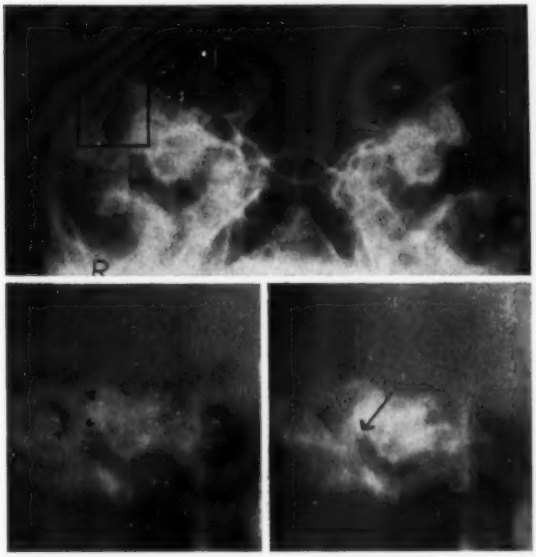


Fig. 2. Case 2. Cholesteatoma of antrum, aditus and attic.

a. Fronto-occipital view. Poor pneumatization. Exact size and shape of antrum (inside square) not demonstrated because of overlapping of structures.

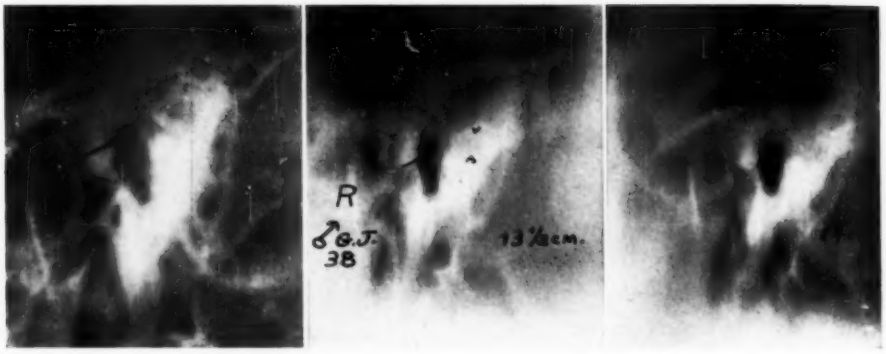
b & c. Planigrams in same view, half centimetre layers. b: sharply defined and widened antrum and aditus ad antrum; c: erosion of roof of attic (arrow).

In chronic middle ear infection as in other pathologic conditions the *indication* for planigraphy will usually be changes suspected from the preceding routine roentgenograms. Consequently, the aim of the examiner will be to *confirm* the findings or arrive at a *definite* diagnosis, as in the following cases.

Case 3. Adult. Periodically discharge, suggestive of cholesteatoma, from right ear past 8 years. In the Runström II projection a wide aditus-attic region with probable erosion was shown (Fig. 3 a). On the planigrams (Fig. 3 b) the contours of the widened aditus-attic region were clear-cut suggesting pressure erosion. Operation showed cholesteatoma of aditus ad antrum and attic.

Case 4. Adult. Periodical discharge past 5 years from left ear, not cholesteatomatous on inspection. Ordinary routine radiograms indicated chronic middle ear infection without definite signs of cholesteatoma; a large cavity in the mastoid process was revealed; progression since 1936 suggested an expanding growth, probably a cholesteatoma (primary or originating from the middle ear?).

In this case the *planigrams* in Stenvers projections gave the best information and suggested the etiology of the growth (Fig. 4).

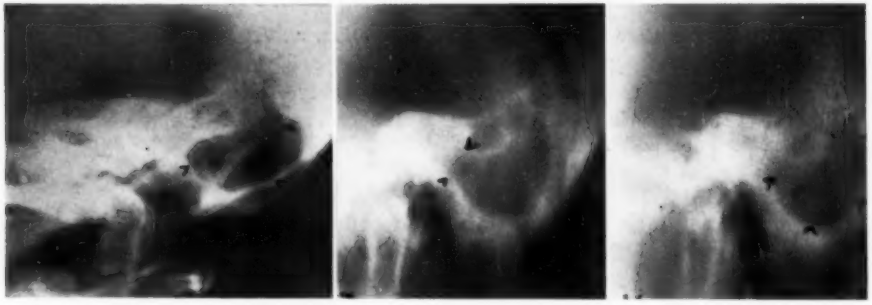


a b

Fig. 3. Case 3. Cholesteatoma of aditus and attic.

a. Runström II projection. Poor pneumatization. Aditus-attic region wide with probable erosion (arrow).

b. Two planigrams in same projection. Clear-cut contours with widening of aditus-attic region suggest pressure erosion. Antrum (small hooks) smaller than expected from radiogram A.



a b

Fig. 4. Case 4.

a. Stenvers projection. Cavity well shown. No demonstrable communication with antral region.

b. Two planigrams in Stenvers projection. Communication (small hooks) between cavity and antral region suggests a pseudo-cholesteatoma — verified at operation.

If the patient's history and the clinical examination, however, suggest disease processes planigraphy may give a positive diagnosis, even if the routine films be negative.

Case 5. Adult. Chronic discharge from right ear, appearance not cholesteatomatous; polyp laterally in external auditory meatus concealed innermost part and ear drum; could not be determined whether middle ear infection or abnormality of the external auditory meatus existed. Planigraphy indicated the diagnosis (Fig. 5).

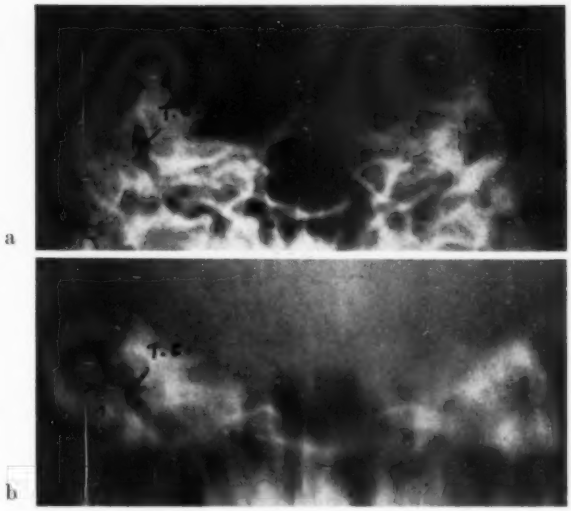


Fig. 5. Case 5.

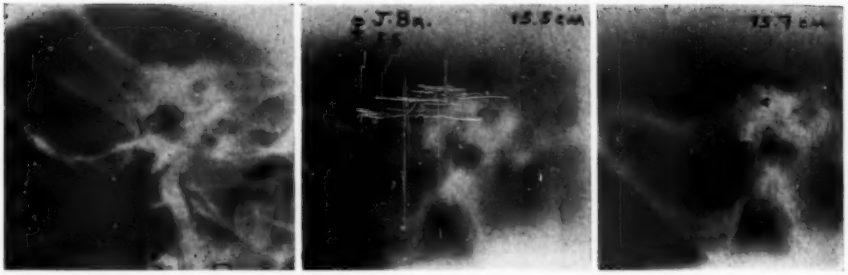
a. Routine fronto-occipital view. Well pneumatized bone with clear cells, excluding middle ear infection. External auditory meatus not visible. Tympanic cavity (T. C.) apparently normal in size.

b. Planigram in same projection. Area of decreased density adjacent to tympanic cavity (small hooks), indicating expanding process, maybe a cholesteatoma of the external auditory meatus (verified at operation). External auditory meatus otherwise obliterated by an exostosis and thus not visible in a & b.

Technique

While horizontal planigraphy with the patient recumbent is exclusively described in the literature (MUNTEAN & FINK and others), the planigraph we use is of the vertical type with the patient sitting. The advantage of the upright over the recumbent posture is that the head of the patient may be easily and correctly adjusted by means of fluoroscopy. It is important that the head be immobilized by means of straps or similar devices and for the patient to be relaxed. *Factors.* Kilovoltage 80—90. Milliamperes 70. Time $2^1/_2$ seconds. Distance 140 centimetres.

The planigraphy is fitted with a moving grid. A serial device dividing a 13 × 18 cm. cassette into two was designed for the lateral positions; its use cuts down secondary radiation and improves contrast. At the same time, it saves film. We find, by measurement, that the skin on the tube side of the patient receives a dose of 2 r during each exposure. Four, or at the most, six films in each position will be required, the num-



a b

Fig. 6. Case 6. Cholesteatoma of the antrum, aditus and attic.

a. Stenvers projection. Antrum not shown to full extent.

b. Two planigrams in Stenvers projection. 2 mm. between sections. Enlarged antrum well demonstrated (small hooks). Arrow points to decalcification and possible erosion of tip of horizontal semicircular canal.

ber depending upon the experience of the operator and the difficulties of the case. A test exposure to check the kilovoltage and depth of the section should be made; correct kilovoltage is essential for optimal results. The temporal bone is usually »cut» at half-centimetre layers. A shorter distance between sections may be necessary for detailing smaller structures, as in the following case.

Case 6. 14 years bilateral discharge in adult. Cholesteatomatous content from right ear and clinical signs of labyrinthitis on the same side. Therefore — the main purpose of the roentgen examination was to demonstrate the extent of the cholesteatoma, and if any erosion of the semicircular canals was present. Routine radiograms revealed signs of pressure erosions of the antrum, aditus and attic. The antrum seemed widened in the submento-vertical view, was found obscured by skull structures in the fronto-occipital view, but was demonstrated to be widened on planigrams in the same projection.

Planigraphy in Stenvers projection with 2 mm. between sections demonstrated a decalcified tip of the horizontal semicircular canal (Fig. 6).

The positions used are illustrated in *Fig. 7. Position A and B* correspond approximately to the *Altschul* and *Runström II* projections, respectively. Angles given are only approximate. No essential effect on the interpretation of the planigram was noted if the angles varied slightly and thus no special device for maintaining the patient's head at a precise angle was found to be necessary.

In *position A*, a 13 × 18 cm. cassette is sufficient for the simultaneous exposure of both temporal regions. The central ray is directed parallel to the sagittal suture of the skull. The antrum is usually projected about 1—1.5 cm. in front of the external auditory meatus. These

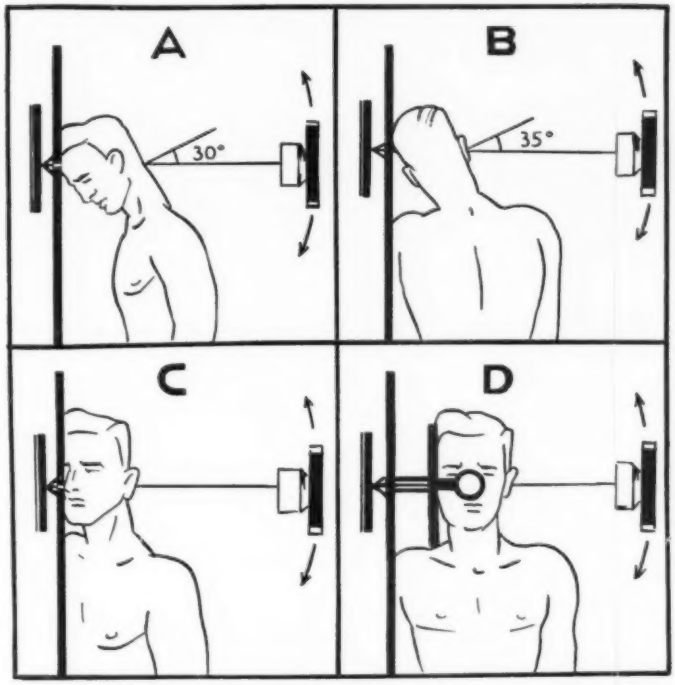


Fig. 7. Diagram of the positions used.

two regions together with the tympanic cavity and the internal auditory meatus are the structures principally shown in this view.

In *position B* the central ray is directed through the external auditory meatus; this is checked fluoroscopically or by a test film. The ear to be examined lies furthest away from the cassette, the patient's head and shoulder resting steadily against the examining table. If the ear to be examined were placed close to cassette the steadying effect would be lost and a special device for holding the head motionless in the desired position would be necessary. The rather long target-film distance in position B does not seem to be a disadvantage, probably because the more easily penetrated antrum-aditus region and tympanic cavity, including the attic, contrast well with the surrounding dense, often sclerotic bone. Neither is the slight enlargement found to be a disturbing factor in estimating the shape and size of the structures.

For interpretation of the normal anatomy shown in these two pro-

jections the reader is referred to the publications of RUNSTRÖM and ZACHRISSON.

Position C corresponds to *Stenvers* projection. The sections detail the internal auditory meatus and mastoid process, demonstrate the antrum and bring out the horizontal semicircular canal. The tip of the nose and the cheek of the patient touch the examining table. The position is checked fluoroscopically and finer adjustments made. The central ray should penetrate the most important region to be visualized.

In the straight lateral *position D* the head should not be tilted towards the table. If the right ear is to be examined, the corresponding shoulder of the patient rests against the examining table. A small adjustable table against which the head is held steadily in a vertical position is necessary (Fig. 7). The external auditory meatus, located by fluoroscopy, should lie in the centre of the field. — The antrum-aditus region is usually projected about three centimetres medially to the outermost part of the external auditory meatus. For information regarding the accurate interpretation of the various sections in position D, the paper by MUNTEAN & FINK will be found to be most valuable.

Choice of Positions

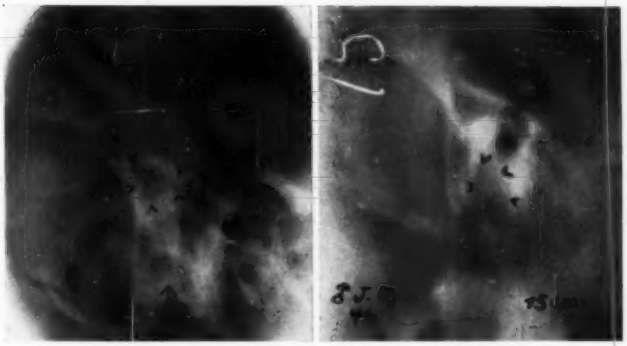
The position to be selected will depend in each case on the preceding routine films and whether these are diagnostically satisfactory. All four positions will seldom be selected. It will be found that one or two usually suffice.

Anatomical details, important surgically, as for example the position of the bulb of the jugular vein, if situated normally or elevated, will be clearly shown.

Fig. 8 is from an adult case (*Case 7*) with discharge — not cholesteatomatous on inspection — from left ear for 6 years. In the planigram (8 b) the displaced bulb of the jugular vein is clearly demonstrated.

As mentioned, position A will be useful in many cases of suspected cholesteatoma of the middle ear, especially to show the size and shape of the antrum (Fig. 2). It may be supplemented by one or more of the other positions (usually B for the antrum, aditus and attic (Fig. 3), and/or position C for the antrum and the horizontal and vertical semicircular canals). Fig. 6 demonstrates (position C) an enlarged antrum (cholesteatoma), and decalcification of the tip of the horizontal semicircular canal as a sign of pressure erosion caused by a cholesteatoma (labyrinthitis).

In another case (Fig. 4) position C was useful in showing a communication from the middle ear to the mastoid process, caused by middle



a b

Fig. 8. Case 7.

a. Runström II projection. Unpneumatized bone. Hooks outline large triangular antrum, fairly broad aditus, wide attic, non sharply defined and thus not characteristic of pressure erosion. Arrow points to area of slightly decreased density, maybe groove caused by elevated jugular vein bulb.

b. Planigram in same projection. Findings in radiogram a confirmed as not typical of cholesteatoma. Displacement of jugular vein bulb verified (hooks).

ear infection with cholesteatoma. We have not succeeded in demonstrating erosion of the roof of the antrum towards the middle fossa of the skull although this condition is mentioned in the literature as likely to be demonstrated by planigraphy.

Position A will be chosen when an erosion of the pyramid of the temporal bone by an acoustic neuroma is suspected. This position is of advantage for comparing the doubtful and healthy sides — on the same film, as in the following case.

Case 8. Adult. Clinical signs suggestive of left acoustic nerve tumour: pneumoencephalography not performed due to threatening papilledema; vertebral angiography unsuccessful. Ordinary routine radiograms of skull and temporal bone showed area suggestive of destruction near left internal auditory meatus.

Fronto-occipital *planigraphy* confirmed the diagnosis (Fig. 9).

In positions C and D the internal auditory meatus may be demonstrated layer by layer, with a suitable depth between each, from different angles. We have no experience as yet regarding the complete usefulness of positions C and D in the diagnosis of acoustic neuromas.

The external auditory meatus may be shown only poorly or not at all in the routine *Altschul* view. Planigraphy in position A usually brings it out excellently, in good contrast to the denser bony wall (Fig. 1 b). If the external auditory meatus remains invisible on the plani-

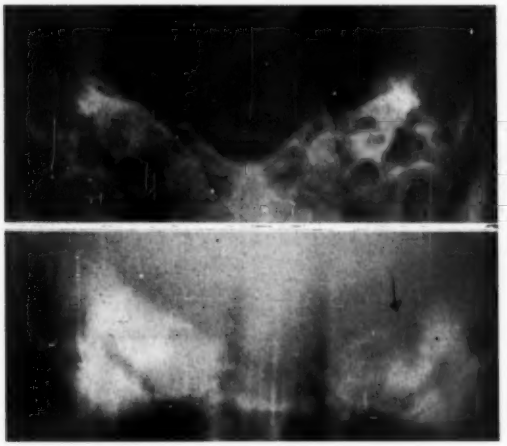


Fig. 9. Case 8.

a. Fronto-occipital view. Arrow points to probable destruction.

b. Planigram same view. Destruction at arrow. Acoustic nerve tumour on left side removed at operation. Marked pressure erosion, corresponding to area of destruction in radiograms, noted.

grams, congenital atresia or marked under-development is the most likely cause. This will probably be the case in most instances where the clinician finds the external auditory meatus partially or completely obliterated. However, an externally situated exostosis, possibly hidden by a polyp, may obliterate the entrance and make inspection of the innermost part of the meatus near the ear drum impossible. In the case shown in fig. 5, the area of decreased density adjacent to the drum — revealed by planigraphy only — corresponded to a cholesteatoma of the external auditory meatus.

Position D (or B) usually shows the facial nerve canal more or less distinctly. Fig. 10 a reveals fracture of the skull in a 18-year-old female with left-sided facial palsy and hematotympanum, following skull trauma. The fracture line extends downwards towards the facial nerve canal, the latter being clearly demonstrated on the planigram (10 B). The ordinary lateral radiograms did not show the canal, which, as demonstrated in the planigram, was involved in the fracture.

Conclusions

Planigraphy of the temporal bone in *chronic middle ear infection* is indicated and may assist the diagnosis:

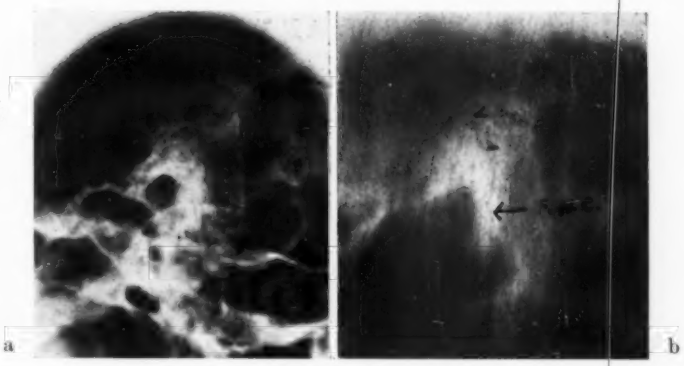


Fig. 10. Skull fracture affecting the facial nerve canal.

a. Runström I projection. Fracture line through left parietal and adjacent part of temporal bone. Facial nerve canal not demonstrated.

b. Planigram, true lateral view. Extension of fracture line to the facial nerve canal (F. N. C.).

1. Where the case history and the clinical findings point to the presence of a cholesteatoma, and satisfactory routine radiograms show »signs suggestive of cholesteatoma» of the antrum, the aditus ad antrum, the attic region or a combination of these.

2. Where the diagnosis of a cholesteatoma is clinically certain, but where the condition of the antrum, the aditus or both does not seem to be obvious.

Planigraphy may be valuable in other lesions of the temporal bone, such as:

a. acoustic nerve tumours causing erosion of bone.

b. cholesteatoma of the external auditory meatus.

c. cholesteatoma of the middle ear causing erosion and communication with the mastoid process.

d. skull fractures extending into facial nerve canal.

e. total atresia of the external auditory meatus (to confirm the diagnosis).

f. exostosis of the external auditory meatus (to determine any inward extension).

g. to avoid complications during radical mastoidectomy planigraphy will demonstrate the anatomy of the temporal bone in doubtful cases and thus prove helpful to the surgeon.

This paper was prepared in collaboration with dr. LARS WINDEREN, of the Ear, Nose & Throat Department, University Hospital, Oslo, regarding the diagnosis of cholesteatoma of the middle ear. It is part of a more extensive work on chronic middle ear infection, to be published later.

SUMMARY

Planigraphy of the temporal bone and its technique are discussed. Planigrams, showing the value of the method as an aid in the diagnosis of various diseases and lesions of the temporal bone, are included and described.

ZUSAMMENFASSUNG

Die Resultate und die Technik der Planigraphie des Temporalbeines werden beschrieben. Planigramme zeigen den Wert der Methode als ein Hilfsmittel zur Erkennung verschiedener Erkrankungen und Veränderungen des Temporalbeines.

RÉSUMÉ

La planigraphie de l'os temporal et sa technique sont discutées. Des planigrammes sont présentés et décrits. Ils montrent la valeur de la méthode pour le diagnostic des diverses maladies et lésions au niveau de l'os temporal.

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FROM THE ROENTGEN CLINIC (DIRECTOR: THOMAS ROSENDAL), THE SUNDBY HOSPITAL, COPENHAGEN, DENMARK.

ROENTGEN EXAMINATION OF THE TEMPORAL BONE FOR CHOLESTEATOMA

by

Th. Rosendal and *H. Ewertsen*

It is generally accepted that cholesteatoma formation takes place secondarily to chronic otitis media by the growth of stratified cornifying squamous epithelium from the wall of the external auditory meatus through a marginal perforation in the tympanic membrane. The desquamated epithelial cells are deposited like the scales of an onion in the recessus epitympanicus, or in the antrum, and gradually give rise to bone destruction. The possibility of perforation into the labyrinth or intracranially, with a spread of the infection, therefore exists.

On the basis of MYGIND's material of 1923—30 from the Municipal Hospital in Copenhagen, comprising 556 patients subjected to radical operation, the frequency with which cholesteatoma formation takes place in chronic otitis media has been fixed at 56 per cent. In material from the Massachusetts Otological Department of 1925—35, comprising 584 patients subjected to radical operation, formation of cholesteatoma was demonstrated in 50 per cent (MAC MILLAN, 1936). On the other hand, a pre-operative diagnosis of cholesteatoma was not so frequently made: only in 97 of MYGIND's patients was the possibility of cholesteatoma raised before the operation, *i. e.* in a little more than one-third of the cases.

In the otoscopic examination a perforation in the membrana flaccida or a posterior marginal perforation in the pars tensa will arouse suspicion of the possible presence of cholesteatoma in the recessus epitympanicus or in the antrum respectively. A demonstration of cholesteatomatous scales will be decisive in the diagnosis, but it is not possible in all cases to ascertain the presence of such scales. In the cases where otoscopic

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examination suggests the presence of cholesteatoma it does not tell us anything about the spread of the process in the temporal bone. By roentgen examination of the temporal bone it should be possible to determine the size and situation of the cholesteatoma formation, provided the bone destruction is extensive enough.

It was previously considered that the roentgenologic diagnosis of cholesteatoma was not difficult. This is still true in the case of large, well-defined cavities demarcated by a dense margin and situated in the area corresponding to the antrum or the recessus epitympanicus. The difficulties arise when an attempt to establish the diagnosis in the early cases with slight destruction is made. This becomes evident when one tries to visualize the antrum and the recessus epitympanicus on films obtained in the projections generally employed (Fig. 1). SCHÜLLER's projection and RUNSTRÖM's II projection are shown at the top of the figure. The patient's head is turned to one side, and the central ray tilted 25° and 35° caudally, respectively. In RUNSTRÖM's III projection the patient's head is also turned to one side; it is seen from above with the forehead to the right and both petrous pyramids turned towards the centre; the central ray is tilted 30° dorsally and directed 7° cranially towards the posterior part of the petrous portion of the temporal bone, the projection producing appearances corresponding to STENVERS' projection and often being termed such. To the left and at the bottom TOWNE-ALTSCHUL's projection or occipital view is shown. The patient lies in the dorsal recumbent position, the central ray being tilted 30° to 35° caudally. The next view is obtained with a projection in which the patient also lies in the dorsal recumbent position, the head is seen from above with the central ray directed through the root of the nose towards the tip of the petrous pyramid. Finally, RUNSTRÖM's IV projection, or the base view, is shown to the right. The head is fully extended backwards, and the central ray directed under the chin. MAYER's projection has not been included; it is used in only a few hospitals in Denmark, and we have no personal experience with it.

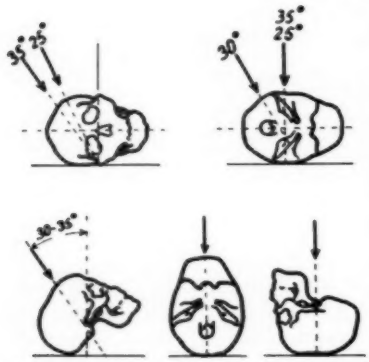

Fig. 1. Top: SCHÜLLER's and RUNSTRÖM's II and III projections. Bottom: TOWNE-ALTSCHUL's projection; projection through the orbits; base view.

Fig. 2 shows the anatomy of the temporal bone in longitudinal section. When this section is compared with SCHÜLLER's projection, it

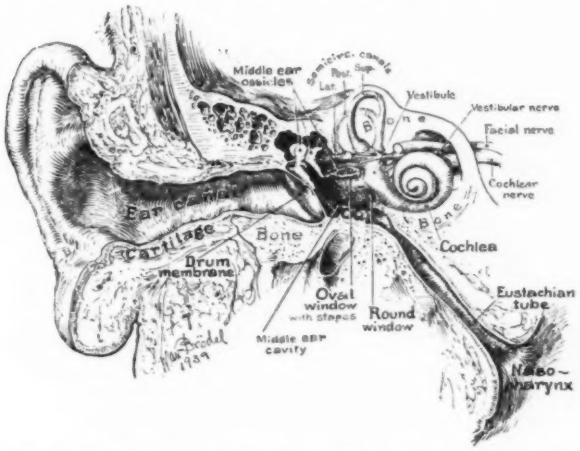

Fig. 2. Longitudinal section through the temporal bone (from BRÖDEL).

appears that the recessus epitympanicus, which is situated immediately above the external auditory meatus, and the antrum, which is at the same level but more posteriorly, will be covered by the dense osseous cloak surrounding the labyrinth and the cochlea. In RUNSTRÖM's II projection with 35° tilt of the central ray there is a possibility of the two cavities being projected free of the labyrinth.

Fig. 3 represents a cross section of the petrous portion and shows the recessus epitympanicus, the antrum and the tympanic membrane from

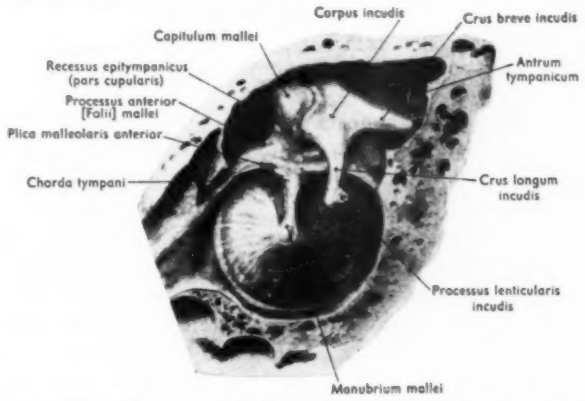

Fig. 3. Cross section through the petrous portion, seen from within (after SPALTEHOLZ).

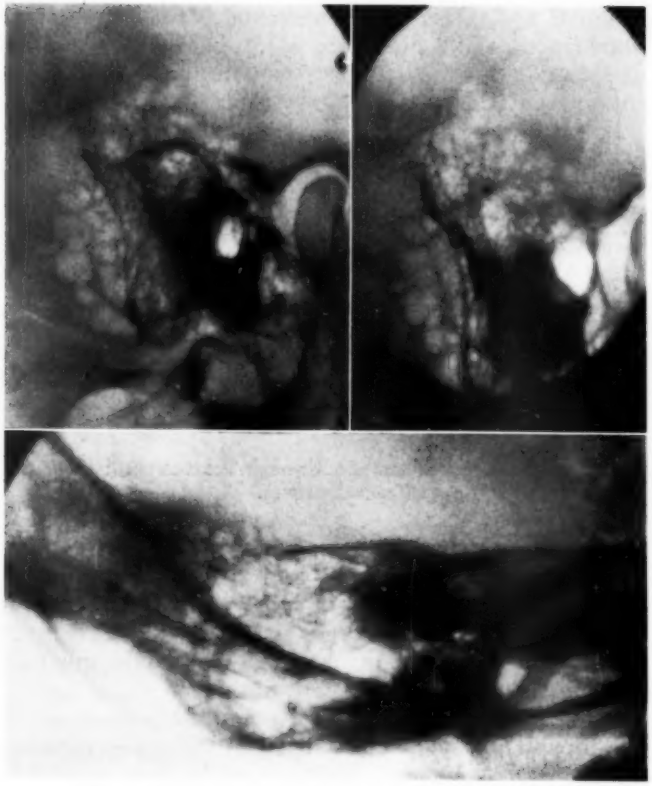

Fig. 4. Top, left: SCHÜLLER's projection; right: RUNSTRÖM's II projection. Bottom: RUNSTRÖM's III projection.

within. The picture shows that the lower edge of the recessus epitympanicus corresponds to the roof of the external auditory meatus, and that the aditus ad antrum corresponds to a plane through the posterior wall of the auditory meatus.

In the film obtained in SCHÜLLER's projection, shown in the left upper segment of Fig. 4, the antrum and the recessus epitympanicus will not appear as cavities for, as already mentioned, they are covered by the dense bone surrounding the labyrinth and the cochlea. This was demonstrated by SCHEUERMANN in 1939 and by WALTNER in 1949 in films made after the introduction of a contrast medium into these cavities.

In RUNSTRÖM's II projection (in the right upper section of Fig. 4) in which the antrum and the recessus epitympanicus are not covered by

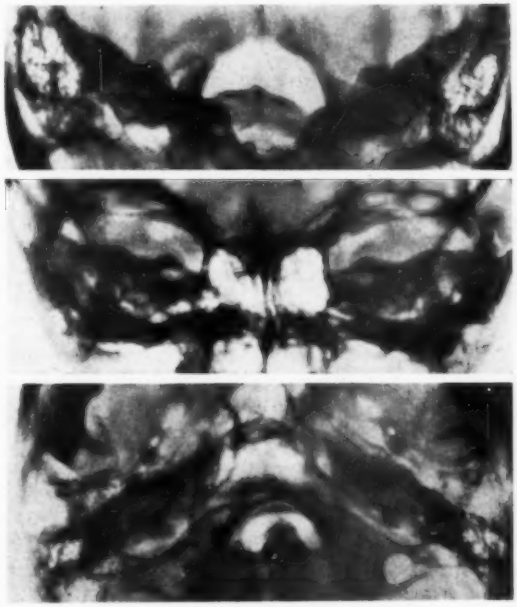

Fig. 5. Top: TOWNE-ALTSCHUL's projection.
Middle: Exposure through the orbits.
Bottom: Base view.

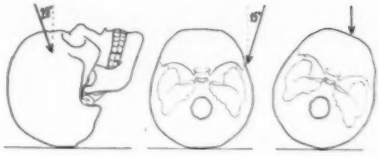

Fig. 6. Fig. 7. Fig. 8.

Figs. 6 and 7. Adjustment for CHAUSSÉ's projection. In fig. 7 the basis of the skull is seen from within.

Fig. 8. Adjustment for exposure through the orbit.

the labyrinth, it is possible to demonstrate a dilatation of the aditus ad antrum in the form of a flattening of the posterior wall of the external auditory meatus and also a destruction in the lower edge of the recessus epitympanicus, which, as already mentioned, corresponds to the superior wall of the porus acusticus externus. These changes were mentioned by WELIN in 1944 and were demonstrated in respectively 68 and 15 patients out of a total of 114 with cholesteatoma of the middle ear verified by surgical operation.

In RUNSTRÖM's III projection (at the bottom of Fig. 4), or in STENVERS' view, the antrum is situated lateral to the semicircular canals,

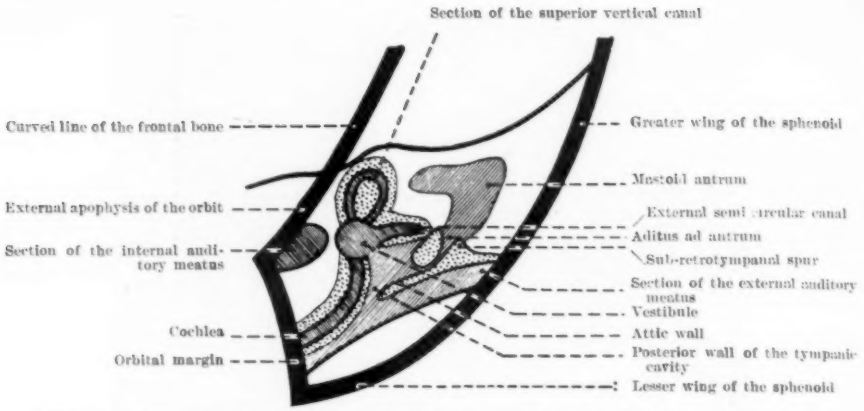

Fig. 9. Diagram of view obtained with CHAUSSÉ's projection (after CHAUSSÉ).

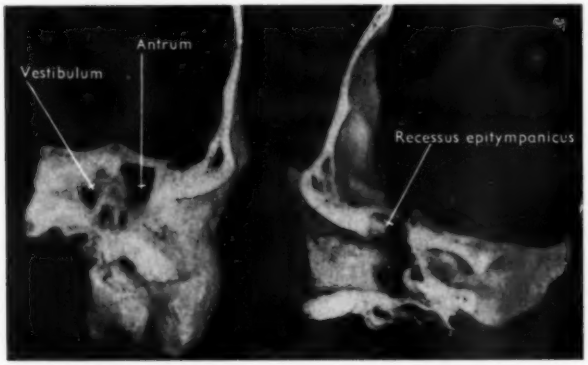

Fig. 10. Oblique section of the left petrous portion through the posterior wall of the external auditory meatus.
Left: The posterior part. Right: The anterior part.

but owing to the great distance between the object and the film as well as to the overlying parts of the skull, fine detail is partially obliterated — the semicircular canals can barely be made out, and the antrum is demonstrated only when large.

At the top of Fig. 5, TOWNE-ALTSCHUL's projection, or occipital view, is shown. Then follows the view through the orbits, and at the bottom, the base view, or RUNSTRÖM's IV projection, is seen. They all show the tip of each petrous pyramid at the same time and are of special value in the study of the porus acusticus internus although the finer

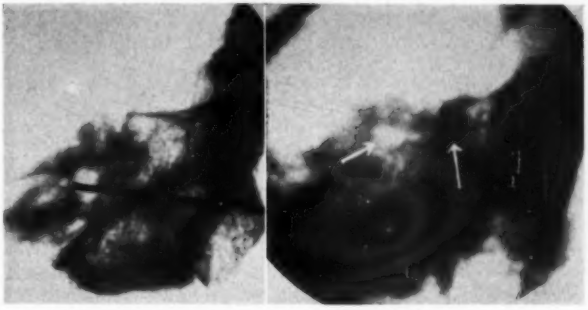

Fig. 11. Left: Isolated temporal bone in CHAUSSÉ's projection; probe in external auditory meatus into the vestibulum. Right: Isolated temporal bone, exposure through the orbit, contrast medium in the antrum. (Arrow ↑ indicates the labyrinth and the contrast medium in the antrum.)

detail of the middle ear is not very evident. Since in the occipital view the antrum is situated laterally to the labyrinth, it is possible, when cholesteatoma is present, to demonstrate a dilatation of the antrum. This was stressed by HOLMES in 1938; among 303 cases of cholesteatoma verified by operation, he found a dilatation of the antrum in 165 cases, chiefly in this projection, *i. e.* in a little more than 50 per cent.

A common feature of the methods referred to is the difficulty in obtaining the antrum and the recessus epitympanicus projected without the labyrinth and to demonstrate a dilatation of these cavities. The changes observed in the posterior wall of the auditory meatus when the aditus ad antrum is dilated and the destruction of the lower edge of the recessus epitympanicus may also be difficult to demonstrate by roentgen examination; these changes may be very slight.

A projection, which gives a clearer picture of the antrum and the recessus epitympanicus than any of the views previously mentioned, has been devised by CHAUSSÉ; the technique is described in Acta Radiol. (1950). We have used the projection at the Roentgen Clinic of the Sundby Hospital since September 1950.

Figs. 6 and 7 show the positioning in CHAUSSÉ's projection. The patient's head is placed on a Lysholm skull table with the : chal region towards the film, and the central ray directed to the temporal region and tilted 20° caudally and 15° medially. We use a cone fitted with a lead diaphragm which produces an area of exposure on the film measuring 5 cm in diameter. We use Ilfex films in a 13 × 18 cm film-holder with fine-grain screens, and two exposures are made per film. Because of the small size of the field the Bucky diaphragm is not used. The patient's

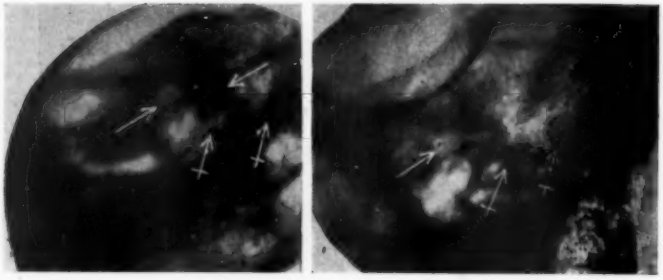

Fig. 12. Temporal bone in two normal cases in CHAUSSÉ's projection. (Arrows ↑ pointing to the vestibulum and lateral semicircular canal: ‡ to the upper wall of the external auditory meatus.)

head is placed with the neck directly on the plate holder on the skull table in order to make the distance between the temporal bone and the film as short as possible. To prevent the plate holder from sliding on the table it is placed on a rubber mat. The ear is covered by a piece of lead in an effort to decrease secondary radiation.

As will appear from Fig. 7 the central ray, in the CHAUSSÉ projection, falls at almost right angles to the anterior and upper surfaces of the petrous pyramid, and the projection gives a radiogram which corresponds approximately to a longitudinal section through the temporal bone.

Fig. 9 is a diagrammatic representation of a film obtained with CHAUSSÉ's projection. The porus acusticus internus is shown medially, together with the labyrinth with the lateral semicircular canal and a part of the upper and posterior semicircular canals uniting in the vestibule, which continues downwards in the basal convolution of the cochlea. This convolution forms the medial wall of the cavum tympani. Lateral to the labyrinth, the antrum is seen and below it, the upper wall of the external auditory meatus with the medial edge to which the tympanic membrane is attached. Above the latter there is an upward extension forming the lateral wall of the recessus epitympanicus; in this the ossicles of the ear are seen.

In a number of films made in CHAUSSÉ's projection after the outlining of the antrum, recessus epitympanicus, semicircular canals, and the ossicles of the ear with contrast medium, and with a probe in the external auditory meatus, we have found complete agreement between the normal anatomical relations and this diagrammatic representation of CHAUSSÉ's projection.

In order to obtain a representation of the finer anatomical details of the temporal bone in another plane, we use still another special ex-

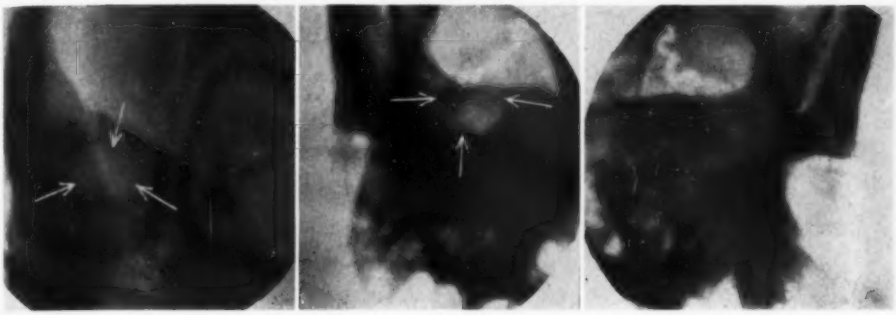

Fig. 13. Left: Cavity the size of a peanut-kernel corresponding to the antrum in right temporal bone (CHAUSSÉ's projection). Middle: The same cavity, projected through the orbit. Right: Left temporal bone, for comparison, projected through the orbit.

posure. As shown in Fig. 8, the patient is in the supine position with the neck on the film and the head turned so as to allow the central ray to be directed vertically into the orbit through the thin posterior wall and so that it strikes the petrous portion from the front, forming an angle of approximately 45° with the axis of the petrous pyramid. The exposure produces a radiogram which corresponds to an oblique section of the petrous pyramid (Fig. 10). The film shows, within the upper and lower borders of the orbit, the vestibulum and the ampulla of the lateral semicircular canal as an entire, triangular cavity, tapering laterally in the lateral semicircular canal. Lateral to this, the antrum and the recessus epitympanicus are projected one over the other; more laterally is the upper wall of the external auditory meatus.

After the introduction of contrast medium into the various cavities we have found that the details seen in this projection also correspond exactly to the anatomical conditions in an isolated preparation of the temporal bone.

Fig. 11 (left) shows a film obtained of a specimen of a temporal bone in CHAUSSÉ's projection after a probe placed in the external auditory meatus has been passed through the fenestra vestibuli into the vestibulum. The various details are shown distinctly. It is even possible to distinguish the canalis facialis at the bottom of the porus acusticus internus. To the right, a film of the temporal bone taken through the orbit is shown. The vestibulum, the ampulla and the lateral semicircular canal are apparent as a triangular cavity within the outline of the orbit. Lateral to this cavity, the antrum filled with contrast medium is seen.

The next two films (Fig. 12) are of normal subjects and made in CHAUSSÉ's projection. All the details mentioned are distinctly seen

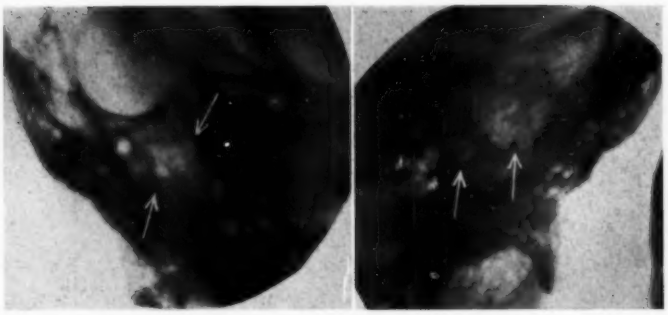

Fig. 14. Left: Right temporal bone in CHAUSSÉ's projection; destruction of medial third of upper wall in external auditory meatus (arrows ↑). Right: Unaffected left temporal bone, for comparison, with normal upper wall of external auditory meatus (arrows ↑).

excepting the upper wall of the external auditory meatus which is covered by a well-developed cellular system. We have observed on several occasions that although the mastoid cells may mask details, pneumatization in patients with chronic otitis media is, as a rule, scanty or absent and there has seldom been any difficulty to distinguish the various details.

The following 4 cases may serve to illustrate the importance of the two projections in diagnosing cholesteatoma in chronic otitis media.

(The author is indebted to Professor R. LUND, Otological Department, Sundby Hosp. and to Chief Physician S. H. MYGIND, Otological Department, Municipal Hosp. of Copenhagen, for permission to use the case histories.)

Case I. G. Ch., ♀, aged 31: At the age of 16 had a left radical mastoidectomy; since then no symptoms from that side. For 2 years discharge from the right ear; during 2 weeks previous to examination, pain in the ear, giddiness and reduced hearing.

Otoscopic examination revealed a polyp covering the drum; no signs of fistula to the labyrinth.

Roentgen examination (Fig. 13) in CHAUSSÉ's projection and through the orbit showed a well-defined cavity the size of a peanut-kernel at the area corresponding to the antrum. No cavity was noted in the SCHÜLLER or STENVERS exposure.

At operation a dilated antrum the size of a peanut was found, filled with cholesteatoma.

Case II. A. J., ♀, aged 60. Since girlhood periodica discharge from the right ear and reduced hearing.

Otoscopic examination: Scanty, foetid pus in large fistula to the recessus epitympanicus + cholesteatoma.

Roentgen examination in CHAUSSÉ's projection (Fig. 14): Destruction of the upper wall of the right external auditory meatus, dilatation of the recessus epitympanicus and a destruction a little over the size of a peanut corresponding to the antrum and the recessus

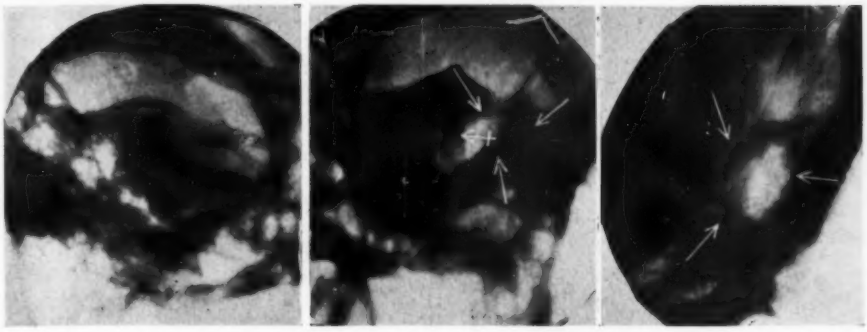

Fig. 15. Right: Cholesteatoma the size of a peanut in the antrum and the recessus epitympanicus in left temporal bone (CHAUSSÉ's projection). Middle: The same cavity, projected through the orbit. A fistula is seen in the lateral semicircular canal (arrow ‡). Left: The unaffected right temporal bone, for comparison, projected through the orbit.

epitympanicus. Views obtained through the orbit gave doubtful information. RUNSTRÖM II: Dilatation of the aditus ad antrum.

Operation: Cholesteatoma the size of a peanut in the antrum and the recessus epitympanicus.

Case III. M. O., ♀, aged 50. Since girlhood, discharge from left ear; during fortnight before admission, pain in the ear.

Otoscopic examination: Enormous marginal defect in the tympanic membrane with large cholesteatomatous masses and denuded bone. Symptoms of fistula in the labyrinth.

Roentgen examination in CHAUSSÉ's projection and through the orbit (Fig. 15): A well-defined cavity larger than a peanut corresponding to the antrum and the recessus epitympanicus with destruction of medial part of upper wall of the porus acusticus externus. Films obtained through the orbit revealed a fistula to the lateral semicircular canal. RUNSTRÖM II showed a large cavity corresponding to the antrum and a wide aditus.

Operation: Cholesteatoma of the size of a peanut in the antrum and the recessus epitympanicus. Elongated fistula measuring 4 mm on the lateral semicircular canal.

Case IV. G. G., ♀, aged 26. Otitis media when a child; since then no symptoms. During 4 months previous to examination periodical oppression and pain in the left ear — reduced hearing, but no giddiness.

Otoscopic examination: fistula to the recessus epitympanicus with foetid pus and cholesteatoma, no definite signs of fistula to the labyrinth.

Roentgen examination in CHAUSSÉ's projection and through the orbit (Fig. 16): Cavity larger than a peanut corresponding to the antrum and the recessus epitympanicus and destruction of medial half of upper wall of external auditory meatus. The view through the orbit showed a distinct fistula on the lateral semicircular canal. RUNSTRÖM II: Cavity corresponding to the recessus epitympanicus and the antrum.

Operation: Large fistula to the recessus epitympanicus with enormous cholesteatoma in the aditus ad antrum. Lateral semicircular canal displayed signs of complete erosion with fistula measuring 5 mm in length.

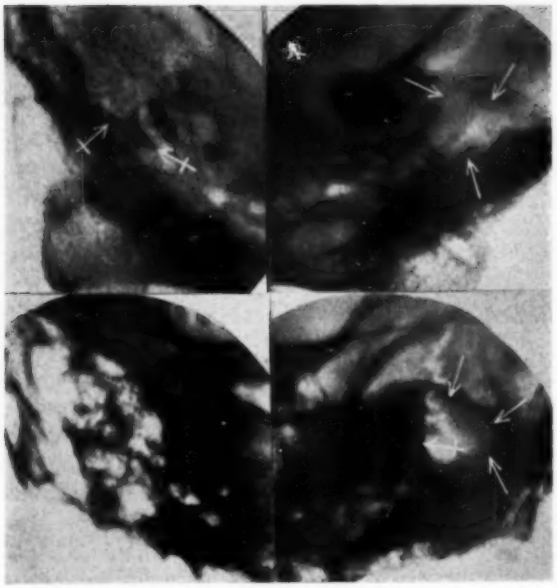

Fig. 16. Top, right: Cavity the size of a peanut corresponding to the antrum and the recessus epitympanicus of left temporal bone (CHAUSSÉ's projection); left: The unaffected right temporal bone, for comparison (arrows ‡ indicate normal upper wall of the external auditory meatus). Bottom, right: The same cavity projected through the orbit. Fistula in lateral semicircular canal (arrow ‡); left: The unaffected right temporal bone for comparison.

As is shown by these 4 cases, the two new projections permit an adequate survey of the antrum and the recessus epitympanicus. It is possible to demonstrate destruction medially in the upper wall of the external auditory meatus, and in two cases it was possible by means of views through the orbit — and only in this projection — to demonstrate the fistula on the lateral semicircular canal. In one of the patients there were definite signs of a fistula to the labyrinth, in the other patient there were none.

We do not claim that the new projections are the only ones by which a diagnosis of cholesteatoma may be made, for in several cases — especially in RUNSTRÖM's II projection — a dilatation of the aditus ad antrum and a cavity corresponding to the antrum and the recessus epitympanicus have been demonstrated. However, the new projections afford such

essentially new contributions to the picture of the anatomy of the temporal bone that we can no longer be content with views in SCHÜLLER's and STENVERS' projections, but must include CHAUSSÉ's projection and the view through the orbit in addition to RUNSTRÖM's II projection before we have exhausted all possibilities of establishing the diagnosis of cholesteatoma by means of roentgen examination.

When a larger series has been collected, an attempt will be made in a subsequent paper to elucidate the accuracy with which the diagnosis of cholesteatoma can be made by means of the two new projections mentioned.

SUMMARY

Of the roentgen views most frequently employed, RUNSTRÖM's II projection affords the best means of depicting the antrum and the recessus epitympanicus and of demonstrating destruction in cholesteatoma. A further projection, described by CHAUSSÉ, and a new one, by the writer, permit more adequate visualization of the anatomy of the middle and inner ear. In these projections the antrum and the recessus epitympanicus are seen free of the labyrinth. Their advantages are illustrated by 4 cases, verified at operation, in which cavity-formation corresponding to the antrum and the recessus epitympanicus was demonstrated; in certain cases there was also destruction medially in the upper wall of the external auditory meatus, and in 2 cases a fistula in the lateral semicircular canal.

ZUSAMMENFASSUNG

Unter den meist benutzten Röntgeneinstellungen bietet RUNSTRÖM's II. Projektion die besten Möglichkeiten, das Antrum und den Rezessus epitympanicus darzustellen sowie die Destruktion beim Cholesteatom zu demonstrieren. Eine weitere von CHAUSSÉ beschriebene und eine neue Projektion des Verfassers gestatten eine mehr adäkvate Sichtbarmachung des Mittel- und Innerohres. Bei diesen Projektionen wird das Antrum und der Rezessus epitympanicus nicht vom Labyrinth überdeckt. Die Vorteile dieser beiden Methoden werden durch 4 operativ sichergestellte Fälle illustriert, bei denen Hohlraumbildungen entsprechend dem Antrum und dem Rezessus epitympanicus demonstrierbar sind. In einigen Fällen fand man auch eine Zerstörung der medialen oberen Begrenzung des äusseren Gehörganges und in weiteren 2 Fällen eine Fistel im lateralen Teil des semizirkulären Kanals.

RÉSUMÉ

Parmi les images les plus fréquemment employées la II^me^ projection de RUNSTRÖM offre certainement la meilleure possibilité de reproduire l'antre et le recessus épitympanique et de déceler les destructions dans les cas de cholestéatome. Une autre projection décrite par CHAUSSÉ, et une nouvelle, par l'auteur lui-même, permettent de rendre d'une manière encore plus adéquate l'anatomie de l'oreille moyenne et interne. Dans ces projections l'antre et le recessus épitympanique se trouvent détachés du labyrinthe. Ces avantages sont illustrés par 4 cas, vérifiés à l'opération, dans lesquels des formations de cavité correspondant à l'antre et au recessus épitympanique ont été révélées. Dans certains cas il y avait également destruction de la partie médiane de la paroi supérieure du conduit auditif externe, et, dans 2 cas une fistule donnant dans le canal semicirculaire latéral.

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INFUNDIBULUM OF THE PATENT DUCTUS ARTERIOSUS STUDIED BY THORACIC AORTOGRAPHY

by

Gunnar Jönsson and *Georg-Fredrik Saltzman*

As far back as the end of the 19th century it was often observed at necropsy that the aorta displayed a more or less funnel-shaped dilatation at the point of origin of a patent ductus arteriosus (ROKITANSKY, WASASTJERNA, THOMA). This infundibulum of the ductus was regarded by THOMA as a traction aneurysm caused by the ductus.

STEINBERG, GRISHMAN and SUSSMAN examined 27 patients with patent ductus arteriosus by means of angiocardiography and demonstrated that the infundibulum of the ductus could be visualized in nearly every case; only in one case was there no evidence of this dilatation of the aorta. They had not seen the dilatation in any condition other than patent ductus arteriosus and they regarded it as an important finding in the differential diagnosis in uncertain cases. They did not, however, consider the finding pathognomonic, but believed it likely that traction on the aorta from any cause would produce the same abnormality. SUSSMAN and BRAHMS have subsequently reported a similar dilatation of the aorta in cases where there was no patent ductus arteriosus. They suggested that this might have been due to traction caused by the ligamentum arteriosum.

As BRODÉN, JÖNSSON and KARNELL (1) have briefly stated, the infundibulum of a patent ductus arteriosus has been observed in this department in a number of patients examined by thoracic aortography. Now that a few more cases have been examined, the results may be submitted in more detail.

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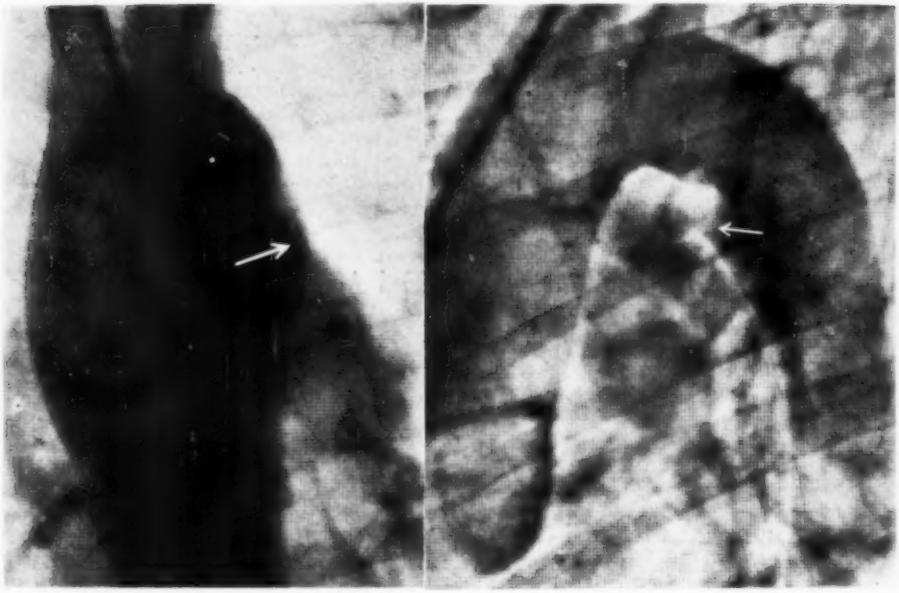

Fig. 1. Infundibulum of patent ductus arteriosus; marked funnel-shaped formation.

Thoracic aortography has been used in 27 cases of patent ductus arteriosus. At one of these examinations the contrast medium was injected into the aorta through a catheter introduced into the aorta via the ductus arteriosus (KARNELL, JÖNSSON and BRODÉN). Patients who had other concurrent congenital cardiac or vascular anomalies were not included. An infundibulum was distinctly visualized in 25 cases while in 2 cases it was absent. The shape and size of the infundibulum showed much variation (figs. 1—3). All stages, from a marked funnel-shaped formation (fig. 1) to a shallow bulge (fig. 2) in the region where the ductus arteriosus leaves the aorta, seemed to occur. In two cases, a uniform widening of the upper part of the descending aorta was observed. Radiograms showing extreme dilatation of this kind (fig. 3) have been published by BRODÉN, JÖNSSON and KARNELL (1).

The ductus arteriosus usually runs for the most part in a dorsal-ventral direction. The infundibulum is thus best visualized in lateral views. In the majority of cases, however, the point where the ductus springs from the aorta is situated slightly medially to the point where it enters the pulmonary artery. Owing to the fact that the path of the ductus is slightly oblique, the infundibulum is often visualized in the antero-

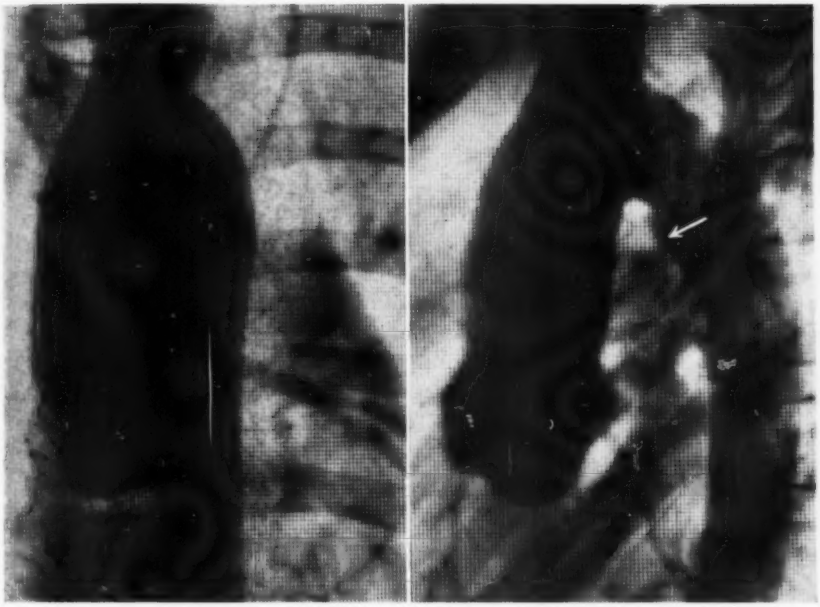

Fig. 2. Infundibulum of the ductus visible as a shallow bulge at the place where the aortic arch passes over into the descending aorta.

posterior view as a more or less distinct bulge on the left border of the aorta. In a few cases the infundibulum of the ductus was more distinct in the antero-posterior than the lateral projections; this was in all probability due to the fact that the ductus ran in an almost true lateral direction.

The ductus arteriosus as a rule arises from the point where the aortic arch passes over into the descending aorta. There are exceptions to this, however. We have encountered a case in which the ductus originated almost in the middle of the aortic arch (fig. 4). In cases of this kind the infundibulum of the ductus is not visible on the a. p. view.

In many cases, the actual ductus is not visualized in a thoracic aortographic examination. The infundibulum of the ductus provides, in these cases, the only means of establishing the exact position of the ductus.

The patients examined in our department were nearly all adults. Through the courtesy of Dr. C. WEGELIUS, of the Norrtull Hospital for Children, we were able to study a number of angiocardiograms obtained from children with patent ductus arteriosus, and to establish that the

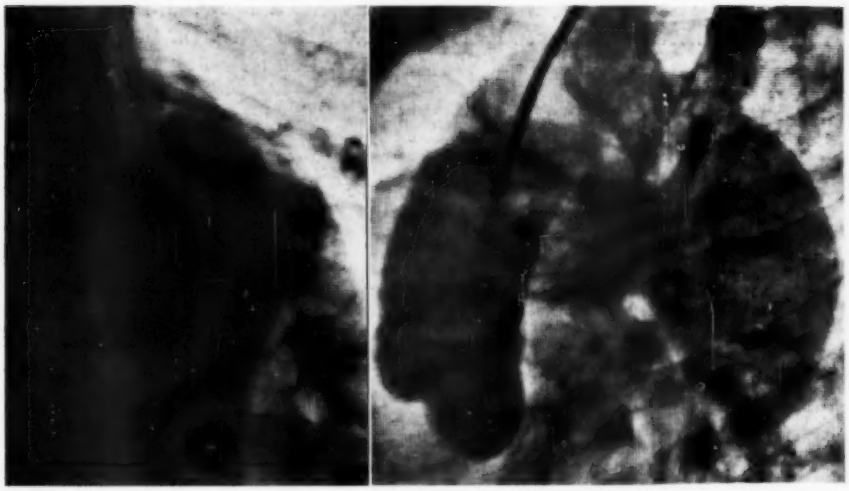

Fig. 3. Uniform widening of the upper part of the descending aorta.

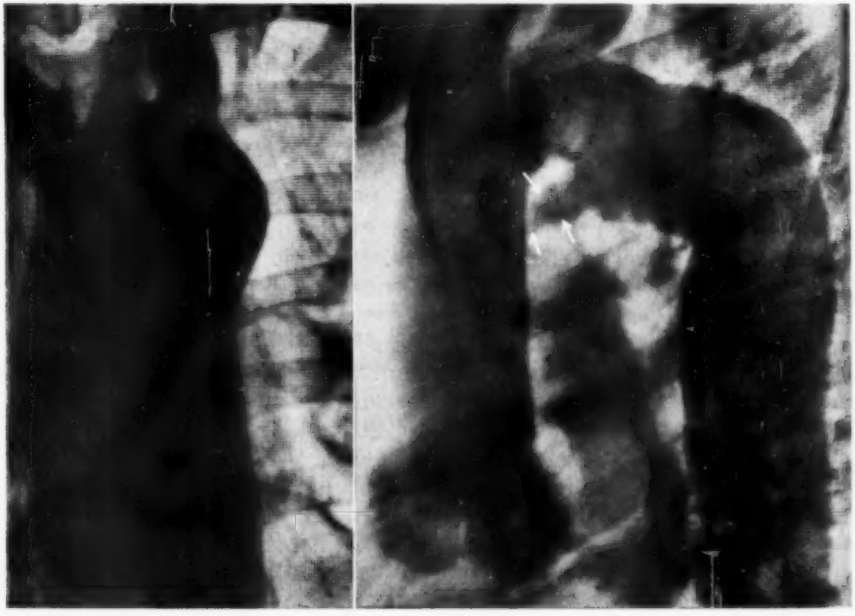

Fig. 4. The ductus arteriosus arises almost in the middle of the aortic arch. No deformation of the aorta visible on the a. p. view.

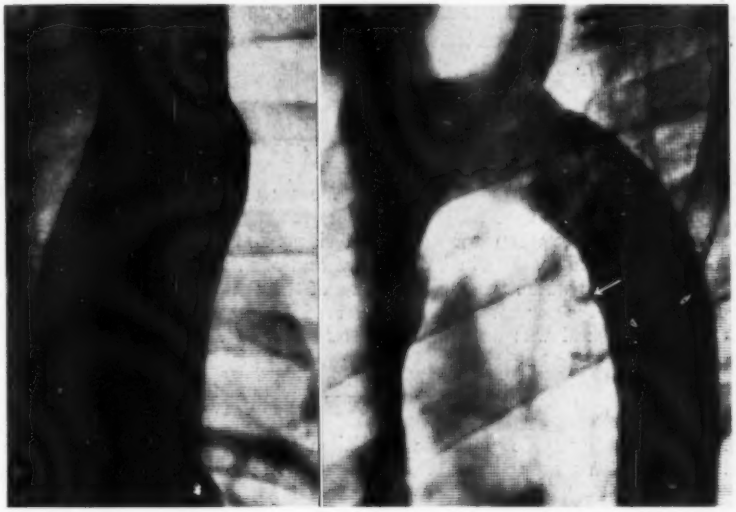

Fig. 5. Normal subject. A small but plainly distinguishable bulge of the anterior wall of the aorta visible in the lateral view only.

infundibulum of the ductus is also clearly visible in small children; the youngest patient was 3 years old.

Thoracic aortography, carried out *lege artis* by a team of experienced roentgenologists and cardiologists, is a relatively risk-free examination (BRODÉN, JÖNSSON and KARNELL) (2). It is only done, however, on definite clinical indications, and it is therefore seldom used in patients with normal aortae. For various reasons, thoracic aortography was, however, carried out in 4 cases where no pathologic lesions of the heart or the great vessels arising from the heart had been found. We distinctly observed in 3 of these cases a shallow bulge of the aorta wall, approximately at the spot where the aortic arch becomes continuous with the descending aorta, *i. e.* at the site where the ligamentum arteriosum usually is inserted into the aorta (fig. 5). The bulge did not project for more than about 1 mm in any of the cases. This dilatation of the aorta in normal subjects was visible in lateral views only. In no case was there any sign of deformation of the aorta shadow in a. p. views.

It may be mentioned in this connection that WEGELIUS, when performing thoracic aortography in a newborn infant, saw a bulge of the aorta at the point of transition between the aortic arch and the descending aorta. With the aid of his rapid casette changer (10 pictures a second) he was able to demonstrate that the contrast medium remained

in this bulge for half a second after the dye had left the other part of the aortic lumen. No contrast passed over from the aorta into the pulmonary artery in this infant.

SUMMARY

Thoracic aortography has been used in 27 cases of patent ductus arteriosus. In 25 cases, a bulge of the aortic wall, of the type described as the infundibulum of the ductus, was observed at the site where the ductus arteriosus leaves the aorta. The infundibulum of the ductus is usually visible in both lateral and a. p. views and its demonstration is often the only way in which the exact position of the ductus can be ascertained. A small bulge of the wall of the normal aorta was observed in a few cases; it never projected more than about 1 mm and was only visible in lateral views.

ZUSAMMENFASSUNG

Thorakale Aortographie wurde in 27 Fällen von offenem Ductus arteriosus angewendt. In 25 Fällen wurde eine Ausbuchtung der Aortawandung, von der gleichen Art wie sie als Infundibulum des Ductus beschrieben ist, an der Stelle gefunden, an welcher der Ductus arteriosus die Aorta verlässt. Das Infundibulum des Ductus ist gewöhnlich sowohl in lateraler als auch in anterio-posteriorer Blickrichtung sichtbar und dessen Nachweis ist oftmals die einzige Methode, die exakte Lage des Ductus zu ermitteln. Eine kleine Ausbuchtung der normalen Aortawandung wurde in wenigen Fällen beobachtet; die Buchtung betrug nie mehr als 1 mm und war nur in lateraler Blickrichtung sichtbar.

RÉSUMÉ

L'aortographie thoracique a été effectuée dans 27 cas de persistance du canal artériel. Dans 25 cas une saillie de la paroi aortique, appelé infundibulum du canal artériel, a été observé au point où le canal artériel quitte l'aorte. L'infundibulum est généralement visible, tant dans les clichés latéraux, que dans les clichés antéro-postérieurs et son identification est parfois le seul moyen d'établir l'emplacement exact du canal artériel. Dans quelques rares cas on a observé une légère saillie de la paroi de l'aorte normale, il ne dépassait jamais un millimètre et n'était visible que sur les clichés latéraux.

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FROM THE ROENTGEN DEPARTMENT (DIRECTOR: BENGT HOLMGREN), SABBATSBERGS HOSPITAL, STOCKHOLM, SWEDEN

A NEW METHOD OF BRONCHOGRAPHY WITH WATER SOLUBLE CONTRAST

by

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A great number of different instruments and mechanical devices have been recommended for bronchography. They demonstrate strikingly many of the technical difficulties of bronchography.

After introduction of water soluble contrast the difficulties have not decreased, but the possibilities of making a complete examination of the bronchial tree have considerably increased.

To obtain a good result in bronchography it is necessary for the investigator to be well initiated into all the different steps of the examination as well as the indications. As most difficulties arise during the »plain» roentgenologic part of the investigation, this must be carried out from the beginning by the roentgenologist himself. He has to supervise the premedication, the procedure of draining the bronchi before and after the examination. He has also to select the anaesthesia used as well as the method of the instrumentation.

It is often a great advantage in bronchography to make the examination with the patient in a standing or sitting position. The patient is easy to move, fluoroscopy is easy and the exposures may be made with sufficient film-focus distance. It is also possible to work rapidly, which is important when using the water-soluble contrast now available.

The main difficulties of bronchography with the patient in the upright posture are to ensure a sufficient filling of the upper lobe bronchi and the apical bronchi of the lower lobes.

To solve that problem a new catheter was constructed.

The principle for the construction has been to block the stem bronchus of one lung immediately below the apical bronchus of the lower lobe and above the upper lobe bronchus. The contrast medium is then injected between the blockings.

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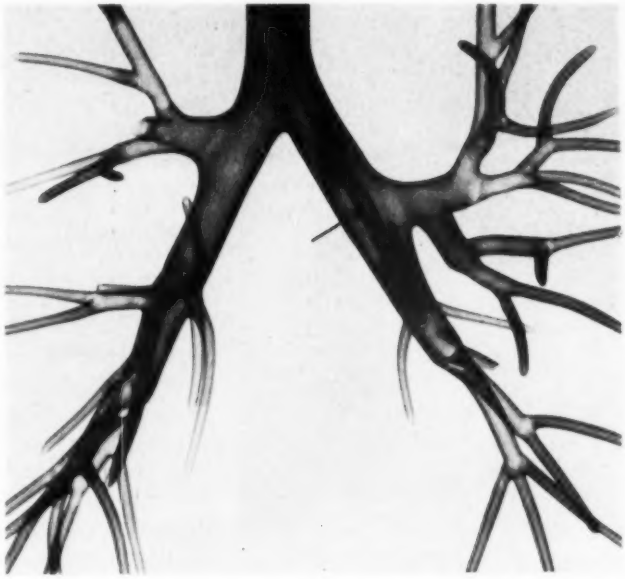

Fig. 1. Glass phantom of the bronchial tree with the catheter in position in the left main bronchus. The small rubber balloons near the tip of the catheter are inflated. Note the catheter opening between the balloons.

The catheter is made of rubber and is 50 cm long. It is slightly bent and roentgen-opaque at the tip. It has two canals. The smaller canal is connected with two small thinwalled rubber balloons near the tip and one larger thick-walled balloon in the upper part of the catheter. The width of the other canal is 15 carrière. This canal is intended for the injection of the contrast medium. It ends in a side-opening between the small balloons.

The communicating system of the small canal and the three balloons is filled with water, non-viscous contrast solution or air. The open end of the system is then closed by a tap or is tied off. By compressing the large balloon, the small balloons will be filled. By applying a little metal clamp to the canal near the large balloon, the smaller ones will retain their shape; after removing the clamp their contents will immediately be sucked up by the large balloon.

As the small balloons are communicating, their pressure upon the bronchial wall will become practically equal and independent of the size of the different parts of the stem bronchus.

Fig. 2.

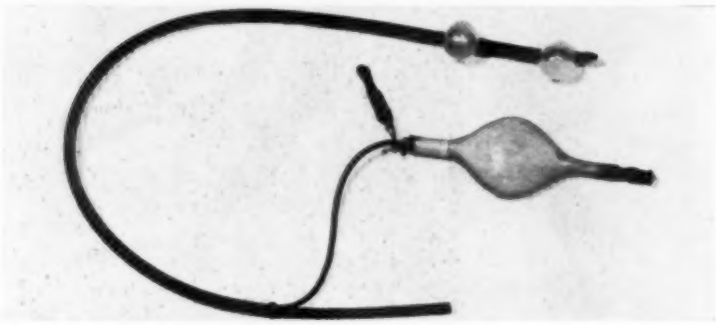

Fig. 3.

Fig. 2. Catheter slightly bent. Larger canal for injection of the contrast medium 50 cm long and of »15 Carrière» diameter.

Fig. 3. Small balloons are inflated by compression of the large ballon. After application of a metal clamp the small balloons retain their shape; when the clamp is removed the small balloons become deflated.

The technique. After premedication of the patient, local anaesthesia of the pharynx is effected with about 0.5 ml of 2 % pantocain. For the larynx, trachea and bronchi, 4—8 ml of 1 % pantocain is advisable. The local anaesthesia should be effective within 10 to 15 minutes. The pantocain should be injected directly between the vocal cords. By changing the position of the patient it is also possible to obtain good anaesthesia of the upper lobe bronchi; this is necessary.

The catheter is then passed into the upper part of the trachea; this is carried out with the aid of curved laryngeal forceps or curved mandrin. The tip of the catheter has to be guided between the vocal cords under observation of the laryngeal mirror. The small metal clamp is fixed on the forehead of the patient by adhesive tape.

The catheter is then placed in position in the stem bronchus of the lung in question under fluoroscopic control. On the left side it is rather easy to place the balloons under and above the origin of the left upper lobe bronchus. On the right side it is rather more difficult because of the short distance between the carina and the origin of the right upper lobe bronchus. After some practice it should not present difficulties.

The fluoroscopy is then discontinued and the small balloons inflated

by compression of the larger balloon after the patient has expired. The communication between the inflated small balloons and the larger one is interrupted by the metal clamp.

The patient's reaction should be carefully observed during the filling of the balloons. Marked dyspnea may be caused by dislocation of the catheter so that the upper small balloon blocks the trachea; rapid deflation of the balloons will immediately remove the respiratory discomfort of the patient.

The contrast medium is injected under further fluoroscopic control. For the upper lobe bronchi the quantity needed will not exceed 10 to 20 ml.

Fig. 4. The clamp is fixed on the forehead of the patient; in addition to blocking the smaller canal it supports the large balloon.

After radiography of the contrast-filled bronchi it is possible to obtain films of the bronchial mucosa. For that purpose about 2 × 20 ml of air is injected after the contrast medium. Films taken after this artificial »cough» will usually give good information on the mucosa.

After deflation of the small balloons, the contrast medium will flow down into the bronchi of the lower lobe which may then be examined.

Thus the total quantity of contrast substance injected is considerably decreased by using it twice in the same lung. It is however often necessary, when the lower lobe is to be examined, to add a small quantity of the medium to that flowing down from the upper lobe bronchus. This is easily done through the catheter without previously inflating the balloons. In this way a complete examination of all the bronchi of one lung is possible at the same time.

A simple and often sufficient modification of this technique is to make a short-time blocking. The balloons are then only inflated during the injection of the contrast medium. As soon as the contrast is injected, the small balloons are deflated. With some practice the time of the blocking can be reduced to only a few seconds.

Contra-indications. It happens sometimes that a patient with good

Fig. 5 a. P. A. view of the contrast-filled upper lobe bronchi and apical bronchus of the lower lobe. a) Lingula bronchus; b) ventral upper lobe bronchus; c) apicoposterior bronchus; d) apical bronchus of the lower lobe; e) tip of the catheter.

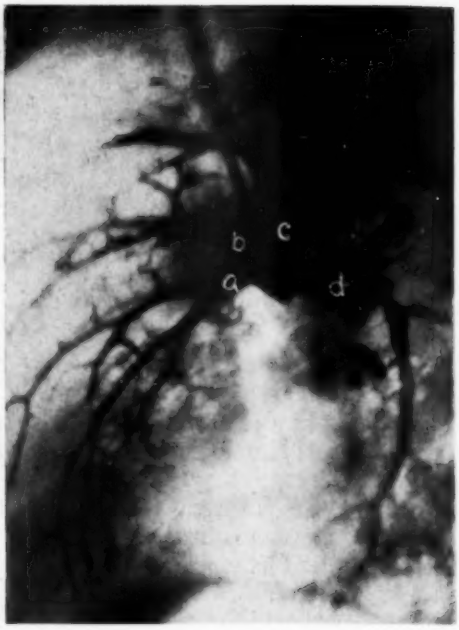

Fig. 5 b. Lateral view of the same case as 5 a. Tuberculous changes in the apical bronchus of the lower lobe and in the posterior branch of the apicoposterior bronchus. The descending branch of the apical bronchus of the lower lobe is congenitally abnormal; is directed downwards towards the diaphragm. a) Lingula bronchus; b) ventral upper lobe bronchus; c) apicoposterior bronchus; d) apical bronchus of the lower lobe; e) tip of the catheter.

respiratory function of the opposite lung and with good cardiac function will become dyspneic when the catheter is blocking a part of the lung. The reason is somewhat obscure but may possibly depend upon the circulatory shunt of the lesser circulation, caused by the blocking of a stem bronchus. In these cases this method should not be used. Cardio-respiratory insufficiency is an absolute contra-indication for this as for other methods of bronchography.

Conclusions

It is possible to make a complete filling of the upper lobe bronchi and the apical bronchus of the lower lobe with the patient in a standing

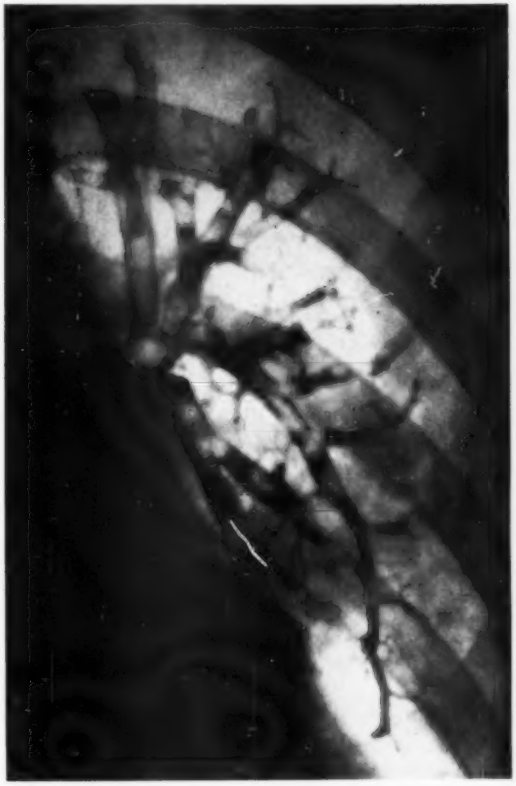

Fig. 6. The injection of the contrast medium between the balloons is followed by the introduction of about 20 ml of air. The balloons are then deflated to allow the contrast medium to flow down into the lower lobe bronchi; in this way a representation of the mucosa is obtained.
Cylindrical bronchiectasis.

or sitting position. By injection of air after the contrast, films of the bronchial mucosa may be obtained. After deflation of the obstructing balloons, the injected contrast medium of the upper lobe bronchus will then flow down into the bronchi of the lower lobe. A complete examination of the bronchi of a whole lung is possible in this way. The quantity of contrast medium may be considerably reduced. The functional shunt of the lesser circulation produced by the blocking of a stem bronchus may in some cases cause dyspnea. In these cases the method should not be used. The examination should only be carried out by skilled operators familiar with different procedures and with the reactions of patients in bronchography.

The method of investigation should be considered as a complement to other means of bronchography. It is especially suited for an examination of the upper lobes and the apical bronchus of the lower lobes.

Fig. 7. Right lung: lateral view; same technique as in fig. 6. Total atelectasis of the upper lobe. Displacement of the middle lobe bronchus upwards. Bronchiectasis of the lower lobe.

SUMMARY

A new method of bronchography is described. By means of two small communicating rubber balloons near the tip of a catheter it is possible to block the stem bronchus of one lung above the upper lobe bronchus and below the apical bronchus of the lower lobe. The contrast medium is then injected between the blocks.

ZUSAMMENFASSUNG

Es wird eine neue Methode der Bronchographie beschrieben. Durch zwei kleine, miteinander verbundene Gummiballons nahe der Spitze eines Katheters ist es möglich, den Stammbronchus einer Lunge oberhalb des Oberlappenbronchus und unterhalb des apikalen Bronchus im Unterlappen zu blockieren. Das Kontrastmittel wird dann zwischen den Blockierungen injiziert.

RÉSUMÉ

Description d'une nouvelle méthode de bronchographie. Grâce à deux ballons de caoutchouc situés près de l'extrémité d'une sonde et en communication l'un avec l'autre, il est possible de bloquer la bronche principale d'un poumon au dessus du lobe supérieur et au dessous de la bronche apicale du lobe inférieur. Le produit de contraste est ensuite injecté entre les ballons.

FROM PHYSICS DEPARTMENT, UNIVERSITY COLLEGE HOSPITAL, LONDON, W. C. 1, ENGLAND

THE INSTALLATION OF Co^{60} IN A GAMMA RAY BEAM UNIT

by

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Radioactive cobalt, Co^{60}, has been suggested as a source of gamma radiation for therapy by a number of writers (*e. g.* MITCHELL 1946; MYERS 1948; and MAYNEORD 1950). It has a mean gamma ray energy about the same as that of radium, and the conveniently long half-life of 5.3 years, which seemed to us to justify its experimental use as a substitute for radium. $Iridium^{192}$ which has also been suggested for such a purpose (FREUNDLICH et al. 1950) has a half-life of only 70 days, which is less convenient. The present investigation was undertaken in order to evaluate the advantages and disadvantages of several curies of Co^{60} in a standard teletherapy unit, and to compare this source with the radium formerly used.

Installation

The telecurietherapy unit is of the pattern made by Messrs. Bryant Symons and Co. Ltd., as originally described by GRIMMETT (1937), but using uranium shielding and applicators (WILSON 1951). The unit was designed to accomodate 10 grams of radium, so we decided to use the equivalent strength of Co^{60} which is 6 curies. This was supplied in the form of ten metal slugs each 0.6 cm. long and 0.6 cm. in diameter, and of about 600 mc. activity. These sources are mounted in ten of the outermost holes of the bobbin, as shown in Figs. 1 a and 1 b. The remaining holes are intended for use when additional Co^{60} has to be added to compensate for decay. Since the Co^{60} decays at the rate of almost exactly 1 per cent. per month, it will be necessary to add further active material once every year or so. It would be a help in identifying the sour-

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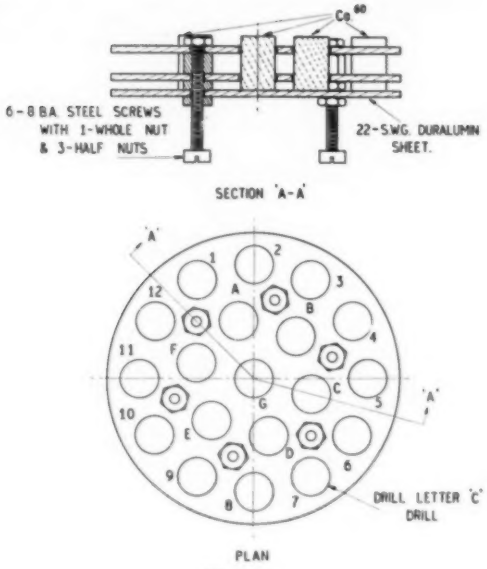

Fig. 1 a.

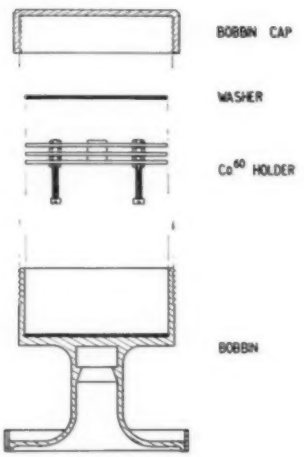

Fig. 1 b.

ces if a number were stamped on the ends of the cylinders before irradiation.

The handling of such a quantity of radioactive material presented problems in protection. Use was made of the magnetic properties of cobalt, and an electromagnetic remote-handling device, 4 ft. long, was constructed as described by MYERS (1948). For the unloading of the 5 gm. of radium already in the unit, and the loading of 6 curies of Co^{60}, the bobbin was mounted on a bench with 6 in. of lead protection and

Table 1

Staff	Duty	Dose in Roentgens
1.	a) Removing the radium from the head to the lead bench, and b) Carrying the radium in lead boxes to the main safe	0.5
2.	Removal of the radium from the bobbin into lead carrying boxes	0.4
3.	Loading the Co^{60} into the bobbin	0.1
4.	Measurement of the strength of the individual Co^{60} sources	0.4
5.	a) Painting the ends of the cobalt cylinders after assembly, and b) Screwing up the cap of the bobbin and, c) Replacing the bobbin in the apparatus.	0.5
6.	Removal of the radium from the carrying boxes and transferring it to the drawers of the main safe	0.5

viewed in a mirror. The exposure was divided among as many people as practicable, all of whom wore film-badges and ionization chambers. The doses received are listed in Table 1.

Measurement of Strength of Sources

The strength of each source was measured by comparison with a radium container whose activity had been calibrated at the National Physical Laboratory. An approximate correction of 15 per cent was applied for the self-filtration of the cobalt sources.

The average strength of the eight cobalt sources first supplied was measured as 616 mc., individual cylinders varying from 595 to 630 mc. The error of measurement is thought not to exceed 10 per cent. Thus the total strength was 4.93 curies, considerably less than the 6 curies which was the strength estimated by the A. E. R. E. Two more cylinders were supplied to make up this deficiency, and the combined strength of the ten cylinders was 6.22 curies.

Radiation Quality

Co^{60} is known to emit two gamma rays, whose energies are 1.17 and 1.33 MeV. For comparison with other gamma ray sources, and with million-volt roentgen ray sources, we wished to know the half-value layer of the Co^{60} radiation. MAYNEORD and CIPRIANI (1947) measured the absorption coefficient of Co^{60} gamma rays in lead under conditions of »good geometry», *i. e.* with as little scattered radiation reaching the ionization chamber as possible. The half-value layer calculated from their results is 10.6 mm. Pb. We also measured the half-value layer of the radiation from the unit itself, using the arrangement shown in Fig. 2. Under these conditions, there are appreciable amounts of scatter reaching the chamber from the walls of the room and also from the lead absorbers. A correction for the former was obtained by measuring the dose-rate with the chamber moved just outside the beam of direct radiation, and a correction for the latter from a formula given by TARRANT (1932). The corrected value

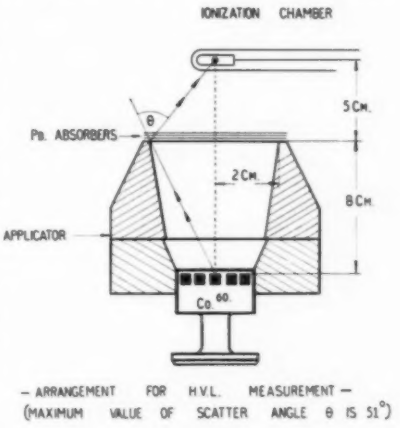

Fig. 2.

we obtained for the half-value layer was 10.5 mm. Pb, as compared with 14.9 mm. Pb before making the corrections. It is interesting to note that the second correction was nearly twelve times the first correction.

Table 2 compares the half-value layer for Co^{60} gamma radiation with that of the radiation from radium and from various roentgen machines operating between 1 and 4 MeV.

Table 2

Source of Radiation	Filtration	H. V. L. in mms. Pb	Reference
Co^{60}		10.5	
Radium	0.5 mm. Pt	9.0	Wyard (unpublished)
1 MeV.X-rays	Inherent filter	4.45	Wilson and Perry (1951)
2 MeV.X-rays	equivalent to	7.4	Wilson and Perry (1951)
2 MeV.X-rays	7.2 mms. Pb	7.2	Miller (1950)
4 MeV.X-rays	2 mms. Pb	11	Mayneord (1950)

Measurement of Isodose Curves

The distribution of radiation in a water phantom, 20 cm. cube, was measured under the conditions of clinical practice. The apparatus was similar to that described by KEMP (1946), except that only one ioniza-

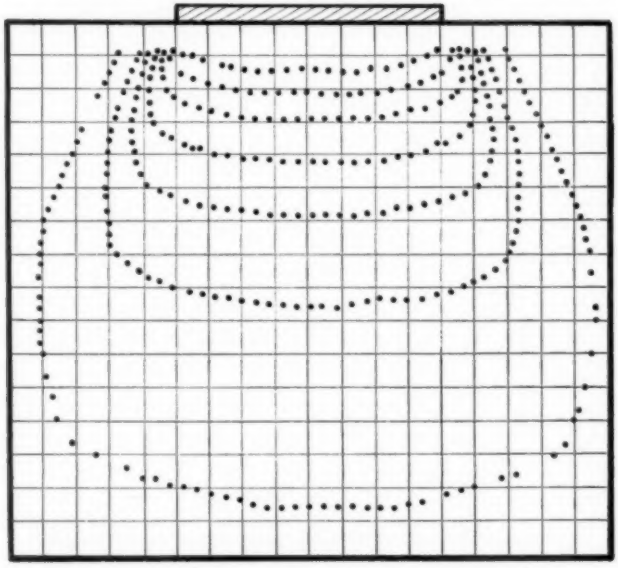

Fig. 3. Isodose chart as plotted by the machine.

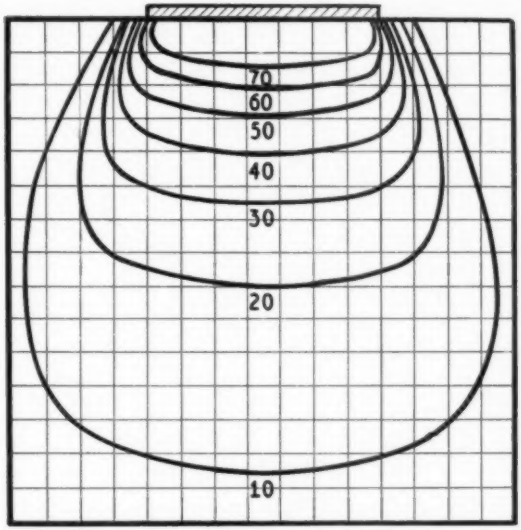

Fig. 4. Isodose chart prepared for clinical use.

tion chamber was used, connected to a d. c. amplifier (WYARD 1950) and the position of this chamber was controlled by long flexible drives from outside the room. The chamber was moved along a path of constant ionization current, corresponding with a selected meter reading. Fig. 3 shows an isodose curve as plotted by the machine, and Fig. 4 shows one prepared for clinical use.

The ionization chamber used was a 100 r. Victoreen-meter chamber, which is 1 cm. in diameter. Although the finite size of the chamber must introduce errors at the edge of the beam, a comparison with a film exposed normally to the beam showed that these errors were small. Fig. 4 shows the sharp cut-off due to the uranium applicators. There does not appear to be any difference between the shape of the isodose curves obtained with cobalt from those obtained with radium in the same unit. A complete set of isodose curves has been prepared, and is available through the Hospital Physicists' Association Diagrams and Data scheme (READ 1945).

Measurements of Dose-rates near the Phantom Surface

The apparatus for plotting isodose curves could not make measurements nearer than 1 cm. to the phantom surface. In order to measure

these dose-rates, an ionization chamber was used whose air volume was in the shape of a disc 1 cm. in diameter and 0.25 cm. deep. The front wall of this chamber was cellophane of thickness 3 mg. per cm², and this was spaced from the end of the applicator by various thicknesses of tissue-like material. With this chamber, the central axis depth dose curves were measured for the first 2 cm., and graphs of the form shown by the solid curve of Fig. 5 were obtained, with a maximum dose at a depth

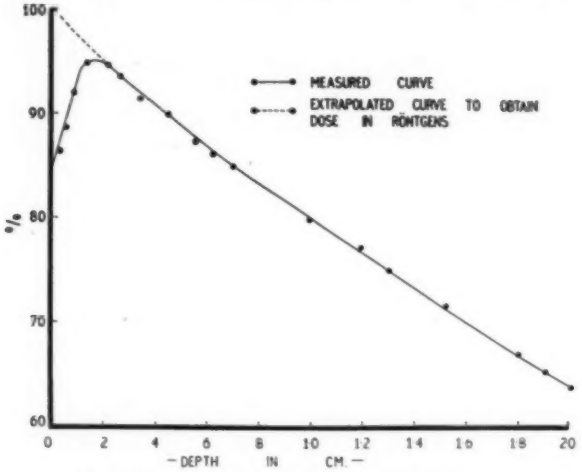

Fig. 5. Central Axis Depth Dose curve.

of about 0.2 cm. The increase in ionization current as the chamber is moved away from the surface of the applicator is due to the fact that the secondary electronic emission from a chromium-plated brass surface is smaller than it is from an »air-wall» surface (WYARD 1951). For positions near the applicator surface, the front wall is not thick enough to produce electronic equilibrium, so that the chamber no longer measures doses in roentgens. As is well-known, it is, in fact, impossible to measure directly the dose in roentgens close to the surface of a phantom with radiation of this energy. This dose was, however, obtained indirectly by extrapolation, giving the broken curve of Fig. 5. In order to check the extrapolation, the ionization current from the disc chamber was measured (a) with a sheet of air-wall material resting on the cellophane front wall, and a sheet of chromium-plated brass behind it, and (b) with the brass touching the cellophane and the air-wall material behind. The effect of replacing the air-wall with chromium-plated brass was to reduce the ionization current to 84 per cent of its former value. This agrees with the figure obtained by extrapolation and also with figures

given by WILSON (1945) for similar effects in the case of the gamma rays from radium.

The question now arises whether to base the isodose curves on the broken curve or on the solid curve of Fig. 5, *i. e.*, whether to measure the dose in roentgens or in energy units (such as ergs per gramme, or ion pairs per cc.). The second form has a more direct connection with the biological effect of the radiation, and has usually been employed in the case of roentgen rays of energy greater than 1 MeV. (MILLER 1950; MAYNEORD 1950, KOCK et al. 1943) and also by DIXON et al. (1951) for Co^{60} radiation. On the other hand, the measurement of the dose in roentgens is more familiar to many radiotherapists, and has been widely used for radium beam units (PATERSON 1948; WILSON 1945). It may be added that the solid curve of Fig. 5 does not necessarily indicate the relative ionization in the tissues of a patient, and to measure this would require the use of an extrapolation chamber (FAILLA 1937). For these reasons, we have decided to use the roentgen as our unit of measurement, in spite of its somewhat imaginary nature near the surface of the applicator.

The fact that ionization in the skin of the patient is less than our curve indicates does not lead to any error in practice. The radiotherapist knows from experience how much skin reaction to expect for a given dose in rontgens delivered from a gamma ray beam unit. The reduced electronic emission from the metal applicators is one reason why the skin reaction is smaller for a given dose in roentgens from a beam unit than for the same dose from a 250 kV roentgen machine (QUIMBY et al. 1939).

The broken curve of Fig. 5 has therefore been used to obtain the central axis depth dose at 1 cm., and all the isodose curves are drawn with reference to this dose at this point.

Measurement of Dose-rate

The measurements of dose-rate described in the previous two sections give only relative values at different points in the beam. It is therefore necessary to make an absolute measurement of dose-rate in roentgens at some point to which all the other measurements can be related. This absolute measurement was made with the Victoreen-meter 100 r. chamber placed in a groove between two wax blocks, so that the centre of the chamber was on the central axis of the beam and about 1 cm. deep. The dose-rate at the surface, calculated from this measurement, was 17.5 r. per minute at 8 cm. source-skin distance, and 9.9 r. per minute at 11 cm. source-skin distance. It was the same for all applicators, within the limits of experimental error.

Protection Measurements

The treatment room, shown in plan in Fig. 6, has two outside brick walls 18 ins. thick, and only one inside wall which is also brick, 2 ft. thick. The control panel for the unit was mounted outside this wall. The applicator head is fitted with stops so that the beam cannot be directed towards the control panel.

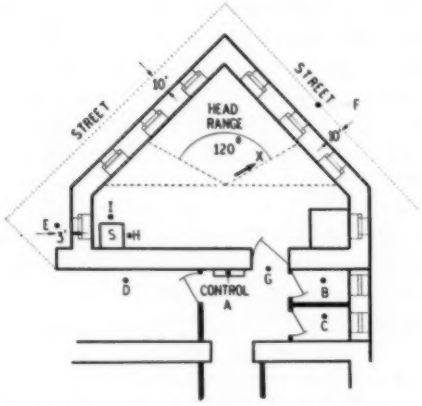

Fig. 6. Plan of the treatment room (see Table 3).

Measurements of stray radiation were made with a »perspex» ionization chamber of about 1 litre volume connected to a d. c. amplifier, and these are recorded in Table 3, where T refers to a dose-rate of 4 microroentgens per second, the maximum permissible dose-rate for continuous exposure. When measurements were made with the source in the head, a wax phantom was placed at the end of the applicator to produce scattering comparable with that from an average patient.

Table 3

Stray Radiation Mesurements

Position of measurement. (See Fig. 10)	Co^{60} in the safe	Co^{60} in the head	Co^{60} near the middle of the connecting tube
A	0.01T	0.01T	0.2 T
B	—	0.16T	0.15T
C	—	0.14T	0.01T
D	0.02T	0.01T	0.2 T
E (10 ft. above street level)	—	0.25T	50T
F (4 ft. above street level)	—	0.1 T	0.02T
G	—	0.7 T	24T
H	0.15T	—	—
I (a) by access port	1.7 T	—	—
(b) by pipe holes	1.5 T	—	—
At floor level of the room above the beam unit. (Ward Sluice room.)		0.3T	11T

Comparison of Radium and Co^{60} in a Gamma Ray Beam Unit

The two sources are very similar in many ways. Clinically there appears no difference between them. Co^{60} suffers from the fact that it decays more quickly than radium and because of this it is necessary to adjust treatment times every two or three months, and to replenish the source once a year or so. On the other hand, the cobalt slugs can have a much higher activity per unit volume than radium tubes. We estimate that, with the specific activity of the present sources, 30 curies could be accommodated in the standard bobbin, and more than this when higher pile factors permit the production of stronger sources. Such a five-fold increase in strength would still not involve significant radiation hazards. Larger source-skin distances could then be used without excessively long treatment times.

If it should be found, as we expect, that Co^{60} is cheaper for a given activity than radium, this would be an additional reason for its use.

Acknowledgements

This work was made possible by the generous co-operation of Dr. Gwen Hilton and the staff of the Radiotherapy Department of this Hospital. Messrs. S. E. R. Mable and G. B. Hodges built the equipment used, and Mr. Hodges, in addition to constructing the apparatus for plotting isodose curves, also prepared many charts and diagrams as well as those reproduced here.

Acknowledgements are also due to the A. E. R. E., Harwell, for the loan of the uranium nozzles and shielding.

SUMMARY

A description is given of the installation of 6 curies of Co^{60} in a gamma ray beam unit formerly containing radium. The measurement of isodose curves and of radiation quality is discussed. Radiation hazards are assessed both for loading the sources into the apparatus and for normal clinical work, and are found to be small. An immediate five-fold increase in activity would be both possible and desirable. It is concluded that for beam therapy, Co^{60} has the advantage over radium.

ZUSAMMENFASSUNG

Die Installation von 6 Curie Co^{60} in eine Telegammaapparatur, die früher Radium enthielt, wird beschrieben. Die Messungen der Isodoskurven und der Strahlenqualität werden besprochen. Das Bestrahlungsrisiko wird sowohl für die Einführung der Strahlenquelle in die Apparatur sowie für die normale klinische Tätigkeit beurteilt und als gering befunden. Eine unmittelbare fünffache Steigerung der Aktivität würde möglich und wünschenswert sein. Es wird konkludiert, dass bei dieser Form von Strahlentherapie Co^{60} dem Radium gegenüber Vorteile besitzt.

RÉSUMÉ

Description de la mise en place de 6 curies de Co^{60} dans un appareil de télécurie-thérapie ayant contenu du radium. Étude de l'établissement des courbes d'isodose et de la qualité du rayonnement. Le danger d'irradiation, pendant le chargement de l'appareil ainsi que pendant le fonctionnement clinique normal, a été évalué et est considéré comme minime. Il serait possible et souhaitable de quintupler d'ici peu la puissance de l'appareil. Les auteurs concluent que pour la curiethérapie le Co^{60} est préférable au radium.

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THE RISK INVOLVED BY BIOPSY IN BREAST CANCER[1]

by

Sigvard Kaae

There is still a marked difference of opinion as to the risk involved by removing biopsy specimens. Previously, it was believed that invasion of cells from a malignant growth into a blood or lymphatic vessel would invariably mean the development of metastases. To-day, it is presumed that malignant cells almost constantly invade the vascular system in numbers far in excess of what the number of metastases lead us to believe, but that most of these cells perish (ENGELBRETH-HOLM (4)). This theory is based int. al. on the studies of POOL & DUNLOP (12) on cancer cells in the blood of patients with malignant disease. It has been pointed out by ENGELBRETH-HOLM that without a doubt, repeated palpations or one rough palpation, let alone the massage of a growth will increase the number of cells invading the blood vessels far more than a biopsy and therefore constitute a far higher risk of producing metastases. Owing to the possible risk of metastasization following biopsy, many surgeons prefer to have biopsy specimens removed from clinically suspicious mammary tumours examined histologically in frozen sections at once, so that if positive, radical mastectomy may be performed at the same session.

It is very difficult to evaluate the risk of performing biopsy in breast cancer and awaiting the result of microscopical examination following normal mounting of the tissue specimen in paraffin. The reason is that biopsy is usually only carried out in clinically uncertain cases which means early cases with a favourable prognosis. When comparing cases submitted to biopsy prior to radical mastectomy with those not sub-

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mitted to biopsy, we are not dealing with two groups uniform from the prognostic point of view. This is the explanation why SIEMENS (14) and TAYLOR & WALLACE (15) found somewhat better results in cases submitted to biopsy. The latter authors, however, found a somewhat higher incidence of local recurrences in the group submitted to biopsy (15 % of 116 cases as compared with 7.5 % of 120 cases). In SCHEEL's (13) series the 5-year results were equally favourable whether or not biopsy had been performed, and the interval between biopsy and radical mastectomy was of no significance. NOHRMAN (11) did not find that biopsy aggravated the prognosis of breast cancer, provided that it was immediately followed by radical mastectomy. As soon as the interval exceeded 3 days, there was an unmistakable tendency to a poorer prognosis. HARRINGTON (8) found a higher incidence of axillary metastases and a poorer prognosis, when radical mastectomy at the Mayo Clinic had been preceded by minor operation elsewhere. He does not, however, state the length of the interval between the minor operation and radical mastectomy.

Author's Material

During the period from 1931 to June 30, 1939, patients with breast cancer treated at the Radium Centre in Copenhagen with preoperative roentgen irradiation and radical mastectomy, sometimes supplemented by postoperative roentgen irradiation, were submitted to biopsy at the commencement of the radiotherapy only if the growth was ulcerated; this was also done in a few instances if the clinical diagnosis was not absolutely definite. In most of these cases the entire tumour was removed although, in a few, aspiration biopsy was employed.

From July 1, 1939 trephine biopsy (1, 2, 3, 9) has been performed routinely in all cases of mammary growths, even though the diagnosis of cancer was beyond doubt, unless biopsy or extirpation of the growth had been performed before the patient was seen at the Radium Centre. In some cases of ulcerated breast cancers, a specimen has been obtained from the margins of the ulceration, but in most cases trephine biopsy has been preferred in order to obtain a specimen representing a more central part of the growth. This systematic removal of biopsy specimens was prompted by the wish for a positive finding at the institution of treatment, since otherwise we were unable to prove the diagnosis of cancer if the tumour yielded completely to the pre-operative roentgen therapy. At the same time, a biopsy specimen obtained prior to the institution of irradiation, presents a chance of histological classification which is far from always possible from an operative specimen obtained following heavy preoperative radiotherapy.

Table 1

Various forms of biopsy prior to preoperative roentgen therapy in 463 cases of technically operable breast cancer in patients treated with preoperative roentgen irradiation and radical mastectomy, sometimes supplemented by postoperative roentgen therapy. During the period 1931 to June 30, 1939, 129 patients were treated and during the period July 1, 1939 to 1944, 334 patients.

	1931—June 30, 1939	July 1, 1939—1944
Trephine biopsy: mammary tumour	0 %	88 %
Trephine biopsy: axillary lymph node	0 %	0.6 %
Biopsy: ulcerated mammary tumour	2.3 %	0.6 %
Biopsy: non-ulcerated mammary tumour	2.3 %	2.1 %
Extirpation: mammary tumour	5.4 %	5.4 %
Extirpation: axillary lymph node	0 %	0.3 %
Aspiration biopsy: mammary tumour	7.8 %	0.9 %
No biopsy at commencement of treatment	82 %	2.4 %

The frequency with which the two forms of biopsy were employed during the 2 periods will be seen from Table 1. In the first group of 129 patients, biopsy was performed in only 18 %, whereas in the second group of 334 patients 97.6 % had been submitted to biopsy (trephine biopsy in 88 %) at the commencement of roentgen therapy. The treatment was the same in both groups with the exception of a different dosage of the supplementary radiation. The second group received heavy preoperative roentgen radiation directed at the breast, axilla, and supra-infraclavicular region, amounting to a total of about 3,500 r measured in the central part of the breast, about 3,300 r in the middle of the axilla, and about 3,300 r in the supraclavicular region, all in the course of one month. As a rule, the patients were not given postoperative irradiation. In the first group, 109 patients received moderate preoperative doses of about 1,600 r directed to the central part of the breast and about 800 r to the central part of the axilla in the course of about eight days; they also received a small dose of postoperative roentgen treatment delivered tangentially to the operative field and amounting to about 1,000 r in the course of one or two weeks. The last 20 cases of the first group received the same dosage as the second group. In all cases surgery consisted in *en bloc* excision of the breast with ample skin, both pectoral muscles, and the axillary fat with the lymph nodes. A comparison of the two groups must therefore show whether biopsy, especially trephine biopsy, produces worse therapeutic results if the treatment — as in this material — is instituted on the same day or within few days. (At the Radium Centre the result of a microscopic examination of a trephine biopsy is usually available within 24 hours.) On the other hand, we cannot compare the cases submitted to biopsy with those in which this procedure was not carried out since, at the beginning of the period, a selection was made;

Table 2

5-year results following preoperative roentgen therapy and radical mastectomy, sometimes supplemented by postoperative roentgen therapy, in primarily technically operable breast cancer. During the period 1931—39, biopsy was performed in only 18 %, during the period July 1, 1939 to 1944 in 97.6 % of the cases prior to the institution of preoperative roentgen therapy. Postoperative deaths: omitted.

Histological stage	1931—June 30, 1939			July 1, 1939—1944		
	Total cases	I	II	Total cases	I	II
Total cases	127	52 %	47 %	313	56 %	43 %
Living symptom-free	49 %	64 %	33 %	56 %	71 %	36 %
Died symptom-free	4.7 %	4.5 %	5 %	6.1 %	6.8 %	5.2 %
Local recurrence in operative field	10 %	7.6 %	12 %	9.3 %	5.7 %	13 %
Supraclavicular metastases with local recurrence	3.9 %	3 %	3.3 %	3.8 %	2.3 %	6 %
Supraclavicular metastases without local recurrence	2.4 %	0 %	5 %	4.5 %	2.8 %	6.7 %
Distant metastases without local recurrence or supraclavicular metastases	34 %	24 %	45 %	25 %	14 %	39 %

Table 3

5-year results following preoperative roentgen therapy and radical mastectomy, sometimes supplemented by postoperative roentgen therapy. This table includes only the cases suitable (according to HAAGENSEN *and* STOUT*) for radical mastectomy. Postoperative deaths: omitted.*

Histological stage	1931—June 30, 1939			July 1, 1939—1944		
	Total cases	I	II	Total cases	I	II
Total cases	124	52 %	47 %	290	59 %	40 %
Living symptom-free	49 %	63 %	35 %	58 %	71 %	39 %
Died symptom-free	4.8 %	4.6 %	5.2 %	6.2 %	7 %	5.2 %
Local recurrence in operative field	10 %	7.7 %	12 %	6.9 %	5.3 %	8.6 %
Supraclavicular metastases with local recurrence	4 %	3.1 %	3.5 %	2.4 %	1.8 %	3.4 %
Supraclavicular metastases without local recurrence	2.4 %	0 %	5.2 %	4.1 %	2.9 %	6 %
Distant metastases without local recurrence or supraclavicular metastases	33 %	25 %	43 %	25 %	14 %	41 %

at that time pre-irradiational biopsy was confined almost exclusively to early, and clinically indefinite, cases of breast cancer and to ulcerated growths.

Tables 2 and 3 compare the 5-year results in the two groups; in part the entire series and in part the patients who should, according to the

criteria of HAAGENSEN and STOUT (7, 5, 6), have been treated by radical mastectomy. Operative deaths have been omitted since these cannot be related to the removal of biopsy specimens. The tables show only a slight difference between the 5-year symptom-free survival in the two groups. If anything, the results obtained in the group from July 1, 1939—1944, submitted to routine biopsy, are somewhat better. It will be seen, therefore, that routine biopsy, followed in most cases by preoperative roentgen irradiation within a few days, did not aggravate the prognosis.

The risk involved by the removal of a specimen by biopsy from a mammary growth, particularly by opening a non-ulcerated growth, is the causing of a local spread on the chest entailing cutaneous or subcutaneous recurrence, lymphogenous metastasization to the regional lymph nodes and hæmatogenous metastasization to distant parts.

Biopsy in cancer always involves the risk of implantation of carcinomatous tissue into the wound — in trephine biopsy, along the entire drill canal; this is a well-known feature; following biopsy without subsequent adequate treatment, extension may be seen along the biopsy canal just as aspiration of fluid from the pleural or peritoneal cavity in cases of carcinosis may be followed by extension along the path of the needle. Biopsy, to be followed by surgical removal of the cancer, must therefore be performed only through tissue which is to be removed at the operation — in this case, radical mastectomy. It is therefore essential to take care not only to cut from a site in the skin sufficiently far from the line of incision in radical mastectomy, but also to avoid getting too deep down into the pectoral muscles in order not to risk implantation into the thoracic wall. If only this be realized, there is no risk of direct implantation of the cancer outside the area to be removed in the course of radical mastectomy. The risk of a superficial local recurrence following biopsy must be due to a spread from the site of the trephine biopsy into the surrounding subcutaneous tissue, and this risk must increase with the length of the interval between the removal of the specimen and the institution of adequate therapy. It is clear from Table 2 that the incidence of local recurrence in the operative field is about the same in both groups of this series. Including only the cases operable according to the criteria of HAAGENSEN & STOUT (Table 3) we arrive at a somewhat lower incidence of local recurrence in the operative field for the period July 1, 1939—1944 (during which biopsy was a routine procedure), especially in histological stage II (8.6 % as compared with 12 %). A more detailed analysis of the incidence of the presumed origin of local recurrence (Table 4) shows almost the same incidence of local recurrence originating superficially in the 2 periods (1st period 3.2 %, 2nd period 2.8 %). Accordingly, there does not seem to be any reason to fear an increased incidence of superficial local recurrence following the trephine biopsy of

Table 4

Incidence of local recurrence in the operative field, originating partly in the chest superficially and partly in the axilla, at the end of 5 years. The table includes only cases that should have been submitted (according to HAAGENSEN *and* STOUT*) to radical mastectomy. All the patients were treated by preoperative roentgen therapy and radical mastectomy, sometimes supplemented by postoperative roentgen irradiation. Postoperative deaths: omitted. The period 1931—June 30, 1939 comprises 124 cases without routine biopsy, the period July 1, 1939—1944, 290 cases submitted to routine biopsy prior to the institution of preoperative roentgen therapy.*

	Histological stages I and II		Histological stage I		Histological stage II	
	1931—30/6 39	1/7 39—1944	1931—30/6 39	1/7 39—1944	1931—30/6 39	1/7 39—1944
Local recurrence originating superficially in the chest ...	3.2 %	2.8 %	1.5 %	3.5 %	5.2 %	3.4 %
Local recurrence originating in the axilla	3.2 %	1.4 %	3.1 %	0.6 %	1.7 %	2.6 %
Local recurrence originating in both regions	1.6 %	0 %	1.5 %	0 %	1.7 %	0 %
	8 %	5.2 %	6.2 %	4.1 %	8.6 %	6 %

a mammary growth carried out a few days before the institution of treatment.

The regional lymph nodes of the breast are in particular the axillary lymph nodes and the internal mammary lymphatic chain. Metastasization to the supraclavicular lymph nodes, the lymph nodes of the contralateral axilla, and the abdominal lymph nodes is more uncommon.

Metastases in the lymph nodes of the homolateral axilla cannot be attributed to a biopsy, if adequate therapy is instituted at once. In radical mastectomy including thorough axillary dissection, these lymph nodes will be removed, and if preoperative roentgen therapy is instituted, their growth will be arrested until radical mastectomy is carried out. Metastasization from the axillary to the supraclavicular nodes is probably of no significance in these cases, if treatment is instituted a maximum of a few days after the removal of the biopsy specimen. Histological examination cannot be expected to reveal small groups of cancer cells which have just appeared in the axillary nodes, so that nodal metastases in the axilla will not be observed more often when treatment is immediately preceded by biopsy. Histological evidence of axillary metastases was available in 48 % of the material from 1931—June 30, 1939 and in 44 % of the material from July 1, 1939 to 1944 (no correction has been made for postoperative deaths). It will be seen from Table 4 that the incidence of local recurrence originating from the axilla is the same in both groups. Trephine biopsy does not therefore appear to increase the risk of recurrence originating from the axilla.

Metastatic deposits in the internal mammary lymphatic chain cannot as a rule be diagnosed clinically, and it is therefore impossible to estimate the risk of metastasization to these lymph nodes following biopsy. Since these lymph nodes are not removed in ordinary radical mastectomy, their involvement may mean a risk of recurrence, even though metastasization to the axillary nodes does not. In some instances, sternocostal recurrences of deep origin have been observed on the affected side; such recurrences probably originate from metastatic deposits in the internal mammary lymph nodes and reach the subcutaneous tissue, often destroying the costal cartilage and sternal border. Among the patients, treated with preoperative irradiation this phenomenon was observed within 5 years in 4 patients — one in the first (*i. e.* 0.8 %) and three in the second group (*i. e.* 1 %). One of the last-mentioned cases, however, was incurable (according to HAAGENSEN and STOUT), and the remaining 2 correspond to 0.8 %. This does not afford any evidence of an increased risk of metastasization to the internal mammary lymph chain following trephine biopsy performed shortly before the institution of treatment; it is difficult to evaluate the risk with certainty.

At times metastatic deposits have been observed in the lymph nodes of the contralateral axilla, and although a tumour is often found in the other breast at a later date, direct metastasization in the lymph nodes of the contralateral axilla does indeed appear to occur. Since the phenomenon, however, is uncommon, and its occurrence difficult to prove, no analysis of its incidence was attempted.

Direct lymphogenous metastasization into the abdomen is also so difficult to evaluate that no attempt was made at determining its frequency.

Since lymphatics are said to pass directly from the breast to the supraclavicular lymph nodes (MORNARD (10)), biopsy may entail metastasization to this site, and since these lymph nodes are not removed in the ordinary procedure of radical mastectomy, biopsy may involve the risk of supraclavicular metastases. As a rule the supraclavicular region is included in the irradiated area, but since metastases in this area probably seldom yield completely to roentgen therapy, we cannot disregard the risk of an increased incidence of supraclavicular metastases on the side of the operation. Tables 2 and 3 show only a slight difference in the incidence of supraclavicular metastases on the operated side at the end of 5 years in the 2 groups with and without routine biopsy. Table 5 gives the incidence of recurrence presumably originating from the supraclavicular region in the two groups. Such recurrences have been somewhat more common in the group with routine biopsy, in histologic stage I in 3½ % as compared with 0 %, and in histologic stage II in 9½ % as compared with 7 %. The difference is slight and far from statistically significant. The most striking difference was found in histologic stage I

Table 5

Incidence of recurrence originating from the supraclavicular region on the operated side within 5 years of preoperative roentgen therapy and radical mastectomy, sometimes supplemented by postoperative roentgen therapy. The table includes only cases suitable (according to HAAGENSEN *and* STOUT*) for radical mastectomy. Postoperative deaths: omitted. During the period July 1, 1939 to 1944 biopsy was performed routinely prior to the institution of preoperative roentgen therapy, whereas during the period 1931 to June 30, 1939 it was performed only as a diagnostic measure.*

Histological stages	Recurrence originating from supraclavicular region	
	1931—June 30, 1939	July 1, 1939—1944
I and II	4.0 %	5.9 %
I	0 %	3.5 %
II	6.9 %	9.5 %

in which the first group had none among 65 patients, whereas the second group counted 6 among 171 (3.5 %). Trephine biopsy had been carried out in 5 and aspiration biopsy in 1 of these 6 cases. One of the patients developed oedema and possibly metastases in the supraclavicular region and therefore received repeated courses of roentgen therapy. Since, however, no other metastases appeared in the course of more than 4 years and the region showed distinct evidence of irradiation changes without definite supraclavicular metastases at the last examination, it is by no means certain that supraclavicular metastases were ever present. One of the other patients developed a cutaneous recurrence in the infraclavicular region and supraclavicular metastases almost simultaneously. This case is listed as a recurrence originating from the operative field as well as from the supraclavicular region, but it does not seem likely that the supraclavicular metastases were »primary». The incidence of recurrence originating from supraclavicular metastases in histological stage I is therefore possibly only 4 among 174 patients submitted to routine biopsy (2.3 %). Furthermore, it is impossible to decide, whether the supraclavicular metastases were secondary to metastases in the lymph nodes of the internal mammary chain.

The total incidence of local recurrence in the operative field and in the supraclavicular region on the operated side is given in Table 6 which shows no difference between the two groups.

Since the total incidence of local recurrence in the operative field and supraclavicular metastases on the operated side is the same in both groups, the incidence of distant metastases without local recurrence or supraclavicular metastases on the operated side may give an indication of the risk of distant metastases following biopsy. Tables 2 and 3 show no marked difference between the two groups. If anything, distant metastases are more common in the group containing few biopsies prior

Table 6

Incidence of recurrence originating from the operative field and from the supraclavicular region of the operated side 5 years after preoperative roentgen therapy and radical mastectomy, sometimes supplemented by postoperative roentgen irradiation. The table includes only cases suitable (according to HAAGENSEN *and* STOUT*) for radical mastectomy. Postoperative deaths: omitted. During the period July 1, 1939 to 1944 biopsy was performed routinely prior to the institution of preoperative roentgen therapy, whereas during the period 1931 to June 30, 1939 it was performed only as a diagnostic measure.*

Histological stages	Recurrence originating from the operative field or the supraclavicular region	
	1931—June 30, 1939	July 1, 1939—1944
I and II	10.5 %	10 %
I	6.2 %	6.4 %
II	14 %	15 %

to treatment; at the end of 5 years the cases operable according to the criteria of HAAGENSEN & STOUT showed 43 % as compared with 41 % in histological stage II, and 25 % as compared with 14 % in histological stage I.

Routine trephine biopsy in carcinoma of the breast does not seem therefore on the whole to aggravate the prognosis, although a somewhat higher risk of supraclavicular metastases cannot be ruled out entirely and although it has proved impossible to evaluate with certainty the risk of metastases in the internal mammary lymph nodes.

In clinically positive cases of breast cancer it is of course unnecessary to perform biopsy before radical mastectomy. The number of clinically uncertain cases depends largely on the experience of the examiner. In order to avoid the possible risk of biopsy and to save time, many clinics have adopted the method of examining frozen sections of the biopsy specimen or extirpated tumour and if the findings are positive of extending the operation to radical mastectomy. This procedure, however, requires a pathologist experienced in the examination of frozen sections and cannot be carried out in hospitals which do not employ their own pathologist. If radical mastectomy is preceded by roentgen therapy, biopsy before the institution of the latter is a great advantage; one may otherwise run the risk of failing to find residual cancer in the operative specimen and thus being unable to confirm the diagnosis.

SUMMARY

The author presents a detailed analysis of a series of operable cases of breast carcinoma treated at the Radium Centre, Copenhagen during the period 1931—1944 with a view to assessing the risks involved in performing biopsy. The patients were treated with preoperative roentgen irradiation and radical mastectomy, in certain instances supplemented by postoperative irradiation. The conclusion, with certain reservations, is drawn that biopsy as a routine measure in cancer of the breast does not appear to affect the prognosis.

ZUSAMMENFASSUNG

Der Verf. legt eine eingehende Analyse einer Serie von operablen Brustkrebsfällen mit der Absicht vor, die Gefahren zu beurteilen, welche die Biopsie mit sich bringt; die Serie ist im Radiumzentrum in Kopenhagen während der Jahre 1931—1944 behandelt worden. Die Fälle erhielten präoperative Röntgenbehandlung und danach wurde die radikale Mastektomie vorgenommen; in gewissen Fällen erfolgte auch postoperative Röntgenbehandlung. Es wird — mit gewissen Einschränkungen — der Schluss gezogen, dass die Biopsie als Rutinemethode beim Brustkrebs die Prognose nicht zu beeinflussen scheint.

RÉSUMÉ

L'auteur présente une analyse détaillée d'une série de cancers opérables du sein traités au Centre du Radium à Copenhague durant la période 1931—1944. Il recherche particulièrement les risques afférents à une biopsie. Les malades ont subi une irradiation préopératoire de rayons roentgen et ensuite une mastectomie radicale, et, dans certains cas, une application postopératoire de rayons roentgen en supplément. Il conclut, sous certaines réserves, que la biopsie en tant qu'examen courant dans les cas de cancer du sein ne semble pas altérer le pronostic.

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FROM THE RADIUM CENTRE (DIRECTOR: JENS NIELSEN, LECTURER TO THE UNIVERSITY OF COPENHAGEN), COPENHAGEN, DENMARK

CYTOLOGICAL CHANGES IN VAGINAL SMEARS IN RADIUM AND ROENTGEN IRRADIATION OF UTERINE CARCINOMA AND THEIR PROGNOSTIC SIGNIFICANCE

Preliminary Report

by

Anna Margrethe Nielsen

Owing to variations in the effect of radium and roentgen irradiation on cancer of the uterine cervix, great efforts have been made to arrive at a method which might indicate the individual prognosis at an early stage of treatment.

History: As early as 1921 FRANKLE & AMREICH studied cellular changes in biopsy specimens removed during the treatment of cervical carcinoma. They found swelling of the cells and interpreted vacuolization of the malignant cells as a response to the treatment. In 1927, DUSTIN studied serial biopsies from 7 cases of epidermoid cervical carcinoma in the course of radiation treatment and divided the changes into four phases: (I) pyknosis of the nuclei and a decrease in the number of mitoses, (II) increase in the number of atypical mitoses, (III) marked increase in the number of atypical mitoses so that no normal mitoses remained, (IV) rise in normal cell division.

MEIGS & PARKER, in 1930, studied daily biopsies and maintained that the increase of atypical mitoses from the fourth day after radium treatment was of decisive prognostic significance.

In 1933 FROLA reported 47 cases of cervical carcinoma examined by means of serial biopsies. He reported an initial increase in mitoses, followed by a decrease and eventual disappearance. In his opinion, complete elimination of the malignant cells between the eleventh and fortieth day of treatment was essential for a good effect. He emphasized the im-

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portance of pyknosis of the nuclei and described infiltration with inflammatory cells and a »maturation process» in the malignant cells.

ARNESON & STEWART, in 1935, reported that the response depended on the swelling of the malignant cells, the pyknotic degeneration of the nuclei, the cytoplasmic tendency to cornification, and moreover on necrosis and a tendency to leucocytic infiltration followed by foreign body giant cell reaction in the tissue.

In 1936, MEIGS, WARREN, et al. investigated 70 cases. Based upon changes which also involved the stroma, the patients were divided into groups corresponding to the effect of the radiation as reflected by the incidence of recurrence.

In 1940, FARROW & STEWART reported a difference in the response to radium and roentgen therapy. In their opinion, biopsy specimens removed during treatment did not yield much prognostic information which was more likely to be gained from the clinical type of tumour.

GILL, in 1944, interpreted unmistakable eosinophilia, observed during the treatment of 7.7 % of all epidermoid cervical carcinomas, as a favourable prognostic sign.

The most careful study of biopsies was published in 1945 by GLÜCKSMANN & SPEAR. In biopsy specimens removed with the utmost care from the growing edge of the tumour these authors identified 4 different kinds of cells: (I) cells in mitosis, (II) resting carcinoma cells, (III) differentiating cells, and (IV) degenerating cells. The cells in mitosis disappeared rather soon and before the malignant cells. The differentiating cells first increased and then decreased in number, while the number of degenerating cells gradually increased throughout the treatment. This was observed in cases showing good response, whereas in cases of poor response, mitoses and malignant cells persisted, and the increase in the number of degenerating cells was slight.

The problem regarding an alteration in the differentiation of tumour cells during radiation treatment was recently discussed by RY ANDERSEN (1949) who found no changes in differentiation during the roentgen irradiation of various human and mouse tumours.

In recent years diagnostic cytology according to the PAPANICOLAOU method has been gaining ground in America. At the Massachusetts General Hospital in Boston, MEIGS and co-workers began to study vaginal smears removed during radiotherapy, and in 1947 the results in 73 cases were published by RUTH M. GRAHAM. Half of these 73 patients showed marked, and the other half only slight, cytological changes. Among the 36 patients who showed marked changes, 28 were alive at the end of 1 year, 5 had died, and 3 could not be traced. Thirty-seven exhibited only slight changes; of these, 26 had died, 8 had persistent disease or recurrence, and only 3 were alive and classified as having no recurrence (although 2 could not be traced) at the end of 1 year.

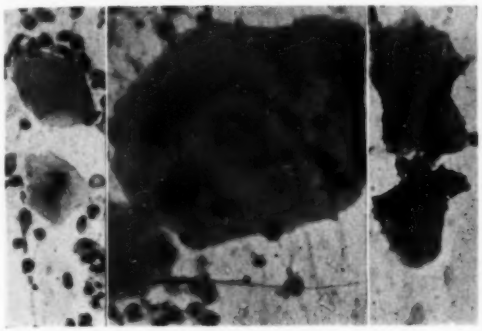

Fig. 1. Left: normal cornified and precornified epithelial cells before treatment. Centre: a cornified cell of average size after seven days roentgen treatment in a case of good response. Right: cornified cells from a patient showing poor response after completion of combined radium and roentgen therapy.

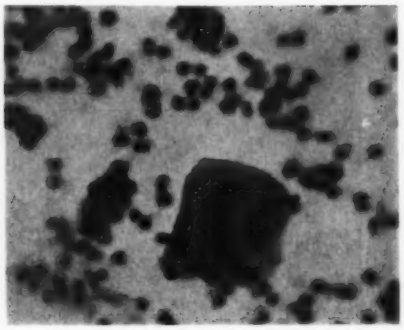

Fig. 2. Cornified cell on 10th day of roentgen treatment. Note network in cytoplasm.

Principles of Radiotherapy in Present Material

From 1948 I have been trying to adapt this method in the therapeutic procedure used at the Radium Centre in Copenhagen, the clinical results of which were reported by FRITHIOF TRUELSEN in 1949. The patients have received standard treatment with moderate individual variations. Small tumours of Stage I or very obese patients were treated by radium only. All others received combined radium and roentgen irradiation: heavy external roentgen irradiation directed at the true pelvis (2 daily sittings of 200 r measured in air) and 2 applications of radium (1,600 — 2,000 mg. hours each) at 10 days' interval after 40 and 60 sittings of roentgen irradiation respectively, the last radium application completing the treatment. Only profusely bleeding tumours were treated first by radium, and large exophytic tumours were sometimes given extra local treatment. The entire period of treatment extends over about 5 or 6 weeks.

Technique

The smears were removed and stained by the Papanicolaou method. Smears were removed about thrice weekly, an average of 12 specimens being obtained from each patient treated by combined radium and roentgen therapy, and 6 specimens from each patient treated by radium alone.

Cellular Changes

The changes observed are identical after radium and roentgen irradiation, but appear somewhat sooner following the former. The first changes

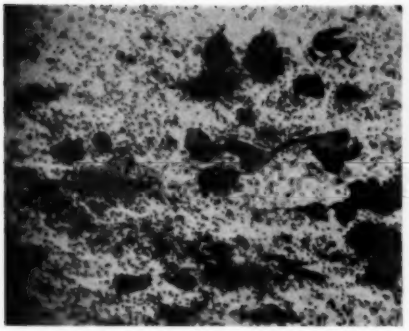

Fig. 3. Bizarre forms of cornified cells toward the end of treatment.

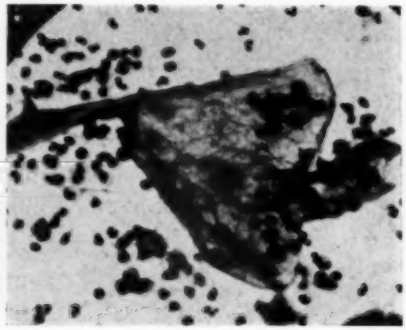

Fig. 4. High power view showing part of fig. 3. Note network in cytoplasm.

are observed in the *basal cells*, provided that the specimen contains any. Elongation of the basal cells and their nuclei may appear as early as the 2nd or 3rd day of treatment, but occasionally not until 10 days after its commencement. Frequently, the cells stain a reddish-brown, instead of the normal basophilic stain. Both phenomena indicate commencing degeneration and may be observed also in patients showing atrophic degeneration of the vaginal mucosa due to causes other than radiotherapy.

Later, there is increasing degeneration, in the form of karyorrhexis of the nucleus or pyknosis, while at the same time the cytoplasm shows delicate striping. Moreover, there is cytoplasmic vacuolization with detritus and leucocytes. At the same time, the entire cell increases in size, acquiring a »blown-up» appearance. Yet, the cytoplasmic-nuclear ratio remains constant, which helps to distinguish these cells from precornified cells. Gradually, absolutely abnormal shapes are encountered, the cytoplasm being elongated into the most bizarre formations; this usually takes place on about the 13th day of roentgen therapy and somewhat earlier in radium therapy (on about the 8th or 9th day). These cells may be distinguished from malignant cells by studying the grade of differentiation of the latter in the same patient; the smears from young patients, however, will often contain no, or only a few, basal cells which are only present in large numbers around or after the menopause, although *precornified* cells show changes corresponding to those just mentioned. At first, the cells increase in size and may become enormous. The nucleus undergoes degeneration, grows pyknotic, irregular, often multiple. At the same time, a delicate, irregular network of fibres appears in the cytoplasm, often interspersed with vacuoles, vacuolization being more common in precornified than deep cells. The former also assume completely abnormal shapes, exhibiting several nuclei, large vacuoles, but no cyto-

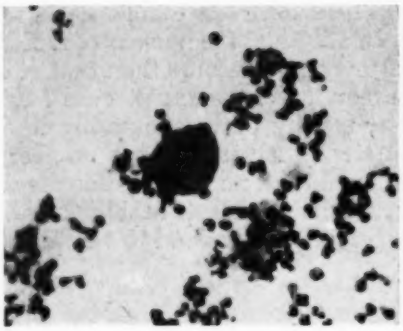

Fig. 5. Enlarged basal cell on 12th day of roentgen treatment. Note cytoplasmatic-nuclear ratio and vacuoles holding leucocytes.

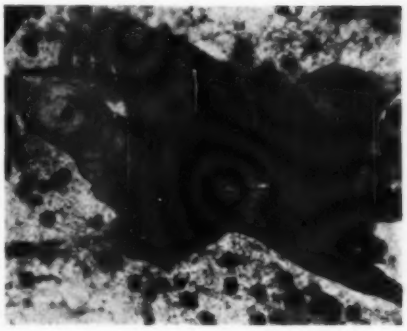

Fig. 6. Abnormal cell formation. Large vacuoles and several nuclei but apparently only one cell.

plasmic border between the nuclei, so that the phenomenon must be interpreted as one large cell. At this stage, there may be an inclusion of leucocytes in the cytoplasm, not to be confused with the accumulation of leucocytes which may be seen on top of the cells at an earlier stage of radiation and in inflammatory vaginal conditions.

The superficial epithelial cells exhibit the same cytoplasmic changes, but their nuclei have already become pyknotic and therefore do not change.

As soon as radiation is commenced, there will be an increase in the number of *leucocytes* which soon show a tendency to arrange themselves on top of and around the epithelial cells, preventing a study of the detailed structure of the latter. This usually happens at the commencement and must be distinguished from the above-mentioned invasion or phagocytosis of leucocytes, which is a later phenomenon. As the leucocytes increase in number, there will be more *histiocytes*, usually of small size, but occasionally in the form of foreign body giant-cells. Regrettably, the smears do not afford evidence as to the presence of eosinophilia (cf. GILL), because of the accumulation of detritus, mucus, and bacteria. Occasionally, there may be a number of *lymphocytes*, although leucocytes always predominate.

The *malignant cells* proper exhibit the same changes as long as they are present in the smear, but it must be emphasized that the specimens are evaluated primarily on the basis of changes in the normal cells.

All the changes described above may be so marked towards the end of treatment, that if only one smear from this period is studied, it may be difficult to decide whether the radiated cells were originally malignant or normal, especially in cases of highly differentiated growths. Throughout

the treatment, however, the malignant cells have less cytoplasm in relation to nuclear size than normal cells. In addition, the nucleus of radiated normal cells is usually less distinct with vaguer contours than that of the pyknotic normal cells. On the other hand, the malignant cells having increased in number for a short time, usually decrease steadily in the course of treatment, while there is a steady increase in the number of normal cells. In exceptional cases the number of malignant cells remains fairly constant during roentgen irradiation but decreases rapidly following the application of radium. These observations correspond to the findings of RUTH M. GRAHAM.

Grouping

In this investigation, the material falls into two rather sharply demarcated groups of good and poor response. In the former, the normal cells soon exhibit rather marked and persistent changes, whereas the malignant cells decrease in number only during treatment. In the latter group, the normal cells show no, or late and quickly decreasing changes, while the malignant cells persist. Occasionally, I have observed changes setting in soon after the commencement of roentgen irradiation, but subsiding again, not to return after the application of radium. Such cases must also be included in the group of poor response.

In the absence of unmistakable changes, setting in within 11 or 13 days of the commencement of roentgen therapy and persisting throughout the treatment, I do not count the case as one of good response. A few patients, however, have exhibited rather slight, but early changes during roentgen irradiation, whereas radium application has been followed by changes so typical and so marked that all forms of abnormal cells have appeared. Such cases are listed as showing good response.

Results

The results among the first 100 patients followed up for from 1 year to 2 years 8 months, were as follows:

	Good	Recurrence	Poor	Recurrence
Stage I	40	1	8	7
Stage II	16	0	5	4
Stage III	11	2	9	7
Stage IV	5	2	2	2
Body of uterus	0	0	2	0
Vagina	1	1	1	1
	73	6 (8.2 %)	27	21 (74 %)

Of these 100 patients, 16 died. Of the latter, 13, belonging to the poor group, died from recurrence or propagation of the malignancy, whereas only 3 of the good response group died. Of them, 1 died from an irrelevant cause 4 days after having been seen at the Radium Centre, where no

recurrence was observed. Of the 2 deaths in the group of recurrence, one occurred after the patient had refused supplementary treatment of the residual tumour (following abortion) and the other after the treatment had to be interrupted as numerous metastatic deposits were detected in the lungs. At the time of writing, the third patient with recurrence in the good response group has signs of recurrence which, however, has not yet been proven (pain in left leg, varying degree of oedema, and fluctuating infiltration). An additional three patients are suffering from recurrence, but are still alive. As for the poor response group, I shall merely add that one patient with cancer of the uterine body underwent a post-irradiation operation which revealed a residual tumour. Since, however, the operation was performed a short time after the radiotherapy, I have not included this case among recurrences; no recurrence developed later.

Varieties of Malignancy

The growths were classified histologically as epidermoid carcinoma in 95 cases and adenocarcinoma in 5. Among the latter, 3 exhibited a good response, viz. 2 in Stage I and 1 in Stage II, all treated by combined roentgen and radium irradiation. (In one of these cases part of the roentgen irradiation was replaced by an extra dose of radium. There has been no recurrence.) Poor response was observed in 2, both suffering from carcinoma of the uterine body. It is worth noting that these patients with adenocarcinoma showed most marked changes following radium therapy.

Conclusions

Despite the rather short follow-up period, the figures clearly indicate that cytological control affords a quick and easily practicable method for determining the effect of radiation (possibly not only the radiosensitivity, but the radiocurability as well) and moreover a method which is not as injurious as the frequent removal of biopsy specimens.

SUMMARY

The cytological changes in vaginal smears from patients with uterine carcinoma were studied in 100 cases during roentgen and radium therapy. Among 73 patients showing unmistakable changes in the smears, only 6 developed recurrences within a follow-up period ranging from 1 year to 2 years 8 months, whereas among 27 cases showing slight changes in the smears, 21 developed recurrences during the same follow-up period.

Cytological control during radiotherapy thus appears to afford a means of obtaining the individual prognosis of uterine carcinoma during treatment.

ZUSAMMENFASSUNG

Die cytologischen Veränderungen in vaginalen Ausstrichpräparaten von Patienten mit Uteruskrebs wurden in 100 Fällen während der Röntgen- und Radiumbehandlung untersucht. Von 73 Patienten, die unverkennbare Veränderungen in den Ausstrichpräpa-

raten zeigten, bekamen nur 6 während einer Kontrollzeit von 1 Jahr—2 Jahre 8 Monate Rezidiv, wogegen von 27 Fällen, die leichtere Veränderungen zeigten, 21 innerhalb der gleichen Kontrollzeit rezidivierten.

Cytologische Kontrolluntersuchungen während der Strahlenbehandlung scheinen also eine Möglichkeit zu bieten, eine individuelle Prognose des Uteruskrebses während der Behandlung zu erhalten.

RÉSUMÉ

Les modifications cytologiques du frottis vaginal au cours du traitement roentgenthérapique ou curiethérapique ont été étudiées chez 100 malades atteintes de cancer de l'utérus. Sur 73 malades ayant présenté de nettes modifications du frottis, 6 seulement eurent des récidives au cours d'une période d'observations allant d'un an à 2 ans et 8 mois, alors que sur 27 cas ne présentant que de légères modifications du frottis, 21 firent des récidives au cours de la même période d'observation.

Le contrôle cytologique pendant la radiothérapie semble donc permettre de porter un pronostic individuel du cancer de l'utérus, au cours du traitement.

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FROM THE RADIUM CENTRE (DIRECTOR: JENS NIELSEN), COPENHAGEN, DENMARK

THE DEMONSTRATION OF CANCER CELLS IN THE URINE AS A DIAGNOSTIC AID

by

Carl Deden

As links in attempts to establish the diagnosis of cancer at the earliest possible moment, cytological examinations are being increasingly utilized.

In 1847, POUCHET (16) examined unstained smears of vaginal fluid and described the cytological changes throughout the cycle and their relation to ovulation and conception. It is a pioneer work of high quality but was not designed to be an aid in the diagnosis of cancer.

Approximately at the same time as well as in the subsequent half century WALSHE (22), LANCEREAUX (10), HAMPELN (7) and HUBER (8) found cancer tissue and cancer cells in expectorates.

LÜCKE & KLEBS (11), QUINCKE (18), BOEGEHOLD (2), SCHWALBE (21) and RIEDER (19) discovered cancer cells in peritoneal and pleural fluid, while SANDERS (20), FERGUSON (5) and QUENSEL (17) found them in urine and vaginal fluid.

It was only after the time of PAUL EHRLICH (4) — the great father of differential staining — that it was possible to improve cytological examinations and consequently make them more extensively used.

In about 1876, after having studied for some time in Europe, the American WILLIAM HENRY WELCH, brought the scientific laboratory system to America where, after the turn of the century, cytological studies began to be carried out.

Among the great cytological names of our time are PAPANICOLAOU (12, 13, 14, 15), FREMONT-SMITH, RUTH GRAHAM, MEIGS (6), AYRE (1) and TRAUT (12).

From Scandinavia a few communications, such as WANDALL's (23) examinations of expectorates in 1944, WIHMAN's (24) studies on trans-

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udates and exudates in 1948, and IVERSEN & KLÆR's (9) examinations of gastric fluids in 1951 have been contributed.

PAPANICOLAOU (13, 14) in his reports of investigations of the urine states that he utilizes 20—40 ml of urine; this he centrifuges, makes smears of the sediment and stains them by a special polychromatic, somewhat complicated staining technique.

The literature contains no mention of the employment of larger amounts of urine.

When I started these investigations more than two years ago, it occurred to me that it might be possible to effect improvements by utilizing a larger amount of urine and a simpler staining technique.

I arrived at the conclusion that 10 times the above amount of urine, i. e. about 300 ml, to which about 100 ml of alcohol had been added as a preservative, followed by storage in a separating funnel for 6 hours, most often yielded a sediment of suitable size. The sediment was centrifuged; smears were made of the precipitate and stained with hematoxylin and eosin. The smears were excellent and often contained myriads o cancer cells in each microscopic field. The presence of an adequate number of cells is of the very greatest importance since cell polymorphism then becomes easier to see.

Details of the technique and evaluation of the smears will form the subject of a subsequent paper.

The roentgenological examination of the urinary tract may present difficulties and cystoscopic examination of the bladder often fails. It should be particularly mentioned that it is often difficult to obtain tissue for histological examination. The cytological examination is without inconvenience to the patient, although an opinion on the smears requires experience and patience.

PAPANICOLAOU (15) has reported in a series of 240 patients that 76 had cancer of the urinary tract and in 43 (57 %) of these definite cancer cells were found. One false-positive case is reported.

The results of my investigation of a 250 patient material show that there were 84 cases of cancer of the urinary tract and in 52 (62 %) definite cancer cells were demonstrated. There are 2, or, at the most 3, false-positive cases in the series.

The following are characteristic case histories.

RC = Radium Centre, Copenhagen; BH(D) & BH(F) = Bispebjerg Hospital, Dept. D & F.

1) RC 28880, ♀ 75 years old: Hematuria in 1941. A carcinoma was found in the right upper part of the bladder; a resection was performed, followed by prophylactic treatment by radium placed in the anterior vaginal fornix. Histological examinations showed squamous cell carcinoma. While the patient was in the Radium Centre no signs were found of any residues or recurrence. In 1947 she had another attack of hematuria. Cystoscopic examination revealed a nodular, slightly bleeding area, measuring almost $2^1/_2 \times$

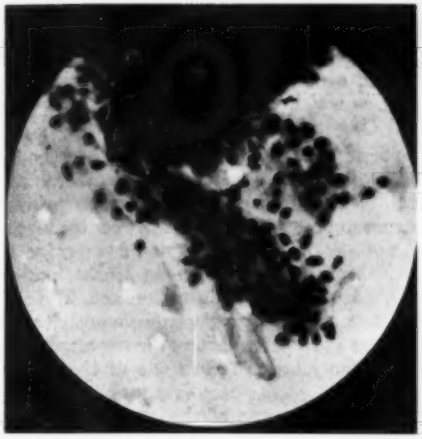

Fig. 1. Undifferentiated cervical carcinoma which has invaded the bladder (× 240).

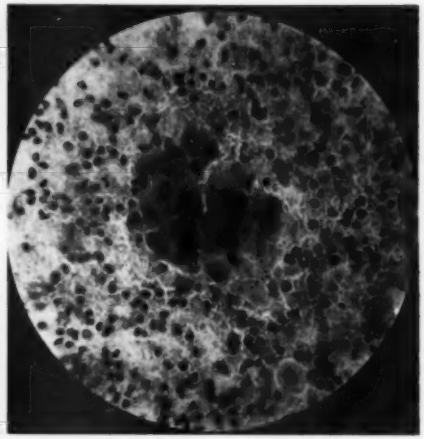

Fig. 2. Carcinoma of the bladder (× 240).

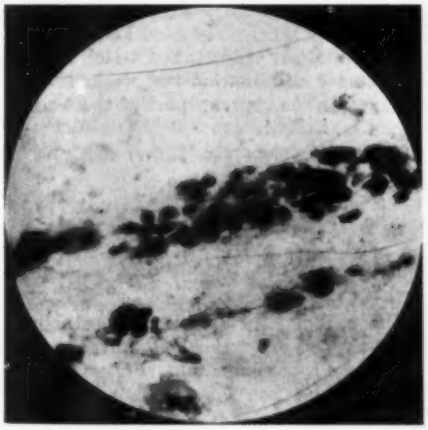

Fig. 3. Carcinoma of the prostate (× 240).

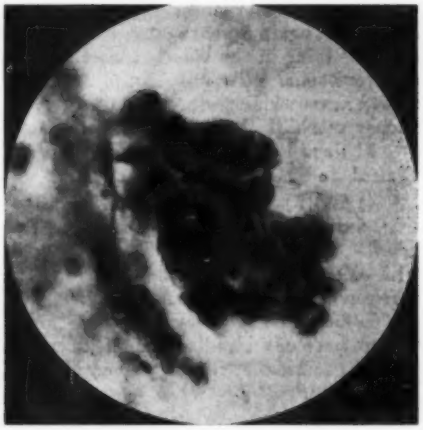

Fig. 4. Carcinoma of the kidney (× 240).

× 2½ cm, at the same site, possibly a recurrence. Attempts to obtain sections for histological examination failed at this and the following cystoscopic examination. A further cystoscopic examination suggested the presence of a diverticulum. The hematuria, however, still persisted. In February 1949 cystoscopic examination failed as the patient was incontinent of urine. Descending pyelography suggested the presence of a growth in the bladder. The urine was examined and definite cancer cells (corresponding to Pa-

panicolaou's class V) were found. A cystoscopic examination 3 weeks later revealed a fibrinous area corresponding to the defect noted in the films and from which a section was obtained. This upon examination showed a squamous cell carcinoma.

We are here concerned with a recurrence of a carcinoma of the bladder in which early cystoscopies failed to establish a diagnosis, in which urography was only suggestive of a tumor but in which a definite cytological diagnosis was possible.

2) RC 53612, ♀ 63 years old: 9 months prior to admission noticed a node in the left supraclavicular region. Histological examination revealed a carcinomatous metastasis. The pathologist drew attention to the possibility of a hypernephroma as the primary lesion. Urography showed that there was no excretion on the right side. A roentgenogram of the right kidney gave no positive information. Seven examinations of the urine for cancer cells were carried out. The first two were negative. The following 3 examinations showed increasing amounts of cells which were suspected as being malignant. The final two examinations showed definite cancer cells (corresponding to Papanicolaou's class V); they were not of the type one would expect to find in hypernephroma, being much more of the type seen in squamous cell carcinoma of the mucous membrane of the urinary tract. The patient died fourteen days later.

Autopsy revealed a constricting squamous cell carcinoma of the upper part of the right ureter with marked renal hydronephrosis.

3) BH(D) 2337/50, ♂ 74 years old: hematuria one month prior to admission. Cystoscopic examination revealed severe cystitis; no evidence of the presence of a growth or of calculi. Pyelography showed the absence of excretion on the left side and deformity of the left kidney. The urine was at the same time examined and showed presumably cancer cells (corresponding to Papanicolaou's class IV). A cystoscopic examination was carried out again 5 weeks later, but did not prove to be of much assistance. Loose portions of tissue lying in the bladder, were subjected to histological examination which revealed only epithelial cells and fibrin. A further cystoscopic examination two weeks later revealed signs which were very suggestive of a growth in the superior part of the bladder. Biopsy established the diagnosis of squamous-cell carcinoma.

51 days had elapsed between the demonstration of presumable tumor cells and the clinical and histological establishment of the diagnosis.

4) BH(F) 747/50, ♂ 54 years old: Six days prior to admission slight pain in the left side, two days previously hematuria. Cystoscopic examination revealed no signs of a growth. Pyelography showed an abnormality of the left kidney, ? calculi, ? growth with calcification. The urine showed presumably cancer cells, probably from a papilloma (corresponding to Papanicolaou's class IV).

Left-sided nephrectomy was performed. The pathological examination established the presence of a bleeding, calcified tumor, almost the size of a tennis ball, in the superior pole of the kidney; it was proved histologically to be a papillomatous adenocarcinoma.

Discussion and Conclusions

Cancer cells were found in the urine of more than 60 per cent of patients suffering from carcinoma of the urinary tract. In some cases the cytological diagnosis was established earlier than the roentgenological or cystoscopical diagnosis. Revision of 2 (3) false-positive cases showed that in one case the original smear had inadvertently been replaced by another, and that another case ought to have been marked as »suspicious». In the third case the diagnosis was uncertain.

As material for examination is easy to obtain, I venture to express the hope that the method may be used partly as a supplementary one and partly in those cases where circumstances prevent procedures such as roentgenological or cystoscopical examinations being carried out. At the same time it is emphasized that a single negative result as well as a single positive result which appears incompatible with the clinical findings must be controlled by a repeated examination.

SUMMARY

After reviewing some of the earlier works on the demonstration of cancer cells in urine, the significance of using a large amount of urine and a simple staining technique is emphasized.

An account is given of the examinations of urine sediments of 250 patients; in 84 of these patients who had cancer of the urinary tracts, cancer cells were demonstrated in 52 (62 %). 2 (3) false-positive cases are discussed, and the conclusion is drawn that the method is a good aid in the early diagnosis of cancer.

ZUSAMMENFASSUNG

Nach einer Übersicht über frühere Arbeiten über den Nachweis von Krebszellen im Urin wird die Bedeutung der Anwendung grosser Urinmengen und einer einfachen Färbungsmethode hervorgehoben.

Ein Bericht über die Untersuchung der Urinsedimente von 250 Patienten wird abgegeben. 84 dieser Patienten hatten Krebs in den Harnorganen; bei 52 Patienten (62 %) wurden Krebszellen nachgewiesen. 2 (3) pseudopositive Fälle werden diskutiert und es wird die Schlussfolgerung gezogen, dass die Methode eine gute Hilfe zur Frühdiagnostik des Krebses bietet.

RÉSUMÉ

Après avoir rappellé certains travaux concernant la mise en évidence de cellules cancéreuses dans l'urine, l'auteur insiste sur l'importance qu'il y a d'opérer sur de grandes quantités d'urine et avec une technique de coloration simple.

Un relevé des examens d'urine faits sur 250 malades montre que chez 84 de ces malades, qui étaient atteints de cancer des voies urinaires, on a découvert des cellules cancéreuses dans 52 cas (soit 62 %). 2 (3) cas faussement positifs sont discutés et la conclusion porte sur la grande importance de cet examen dans le diagnostic précoce du cancer.

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FROM OSLO KOMMUNALE LEGEVAKT (DIRECTOR: GUNNAR JOHNSON).

OSTEOCHONDROSIS DISSECANS IN TWO BROTHERS. THE PRE- AND DEVELOPED STATE

by

Hans Novotny

In an earlier paper I have given clinical and radiologic evidence that a pre-state of osteochondrosis dissecans (o. d.) exists and, discovered in time, may readily be cured by immobilization in plaster.

The following two cases of o. d. in brothers again demonstrate this and support the correctness of RIBBING's thesis that o. d. develops from the epiphyseal accessory osseous nuclei, observed so often in children at certain ages. They indicate furthermore the importance of the constitutional factor in the establishment of this disease.

There was no family history of joint symptoms and, particularly on the mother's side, nothing suggestive of osteochondrosis dissecans. Both parents had participated actively in sports. There was no consanguinity, the parents coming from different countries; the boys were their only children. The father's elbows showed a deviation from the normal, in so far as there was some degree of varus instead of a slight degree of valgus. Both sons, however, had pronounced cubiti vari. The elbows of the boys were radiologically examined. The elder had an accessory osseous nucleus at the epiphysis of the trochlea humeri, the younger two osseous nuclei at the trochlear epiphyses. The films were obtained when both boys were approximately of the same age. Nothing abnormal could be detected on radiologic examination of the hip-joints of the younger boy.

The elder brother was 12 years old when, as he went downstairs, his right knee suddenly became painful and locked, so that he was unable to extend it completely or to put weight on it. An examination immediately afterwards showed slight hydrops of the right knee and pronounced tenderness of the dorsal part of lateral femoral condyle, which felt somewhat irregular. There was about 20 degrees of permanent flexion; further flexion was only little restricted but was performed slowly and with a moderate degree of pain.

Roentgen examination revealed typical o. d. of the lateral condyle of the right femur, without displacement of the associated loose body (fig. 1). Nothing abnormal could be detected in the left knee-joint.

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Fig. 1 a. Osteochondrosis dissecans of right lateral femoral condyle of boy aged 12.

Fig. 1 b. Same knee taken in 45° of flexion.

Fig. 2 a.

Fig. 2 b.

Fig. 2 a and b. Pre-state of o. d. in right medial femoral condyle of the first boy's brother, when aged $11^1/_2$.

Two years later his younger brother, then aged 11 years and 7 months, suddenly also developed pain in the right knee-joint; he could recall no obvious trauma.

On examination of the knee there was slight hydrops, but no restriction of movements, which were, however, performed slowly because of the pain. There was tenderness on the dorsal aspect of the medial condyle of the right femur. Roentgen films showed in the region of the right medial femoral condyle an o. d.-like focus, which differed from his elder brother's in that it was not so sharply defined (fig. 2). The medial condyle of the left femur showed irregularities, often seen at this age and which indicated in this case recent union of the ossicula with the epiphysis (fig. 3).

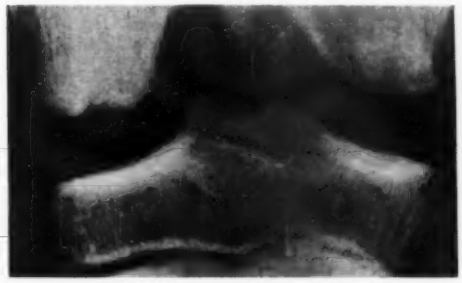

Fig. 3. Left knee of same patient as fig. 2, showing irregularities at medial femoral condyle (taken in 45° flexion).

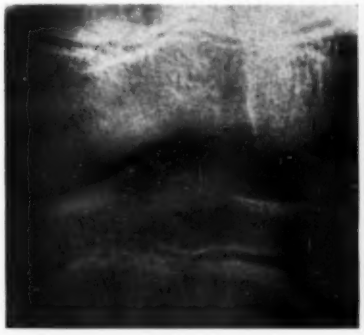

Fig. 4 a.

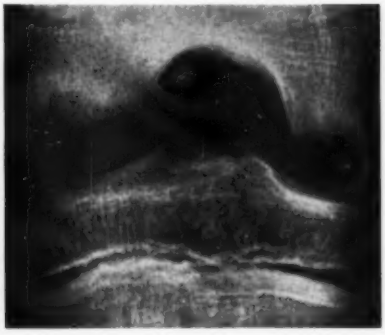

Fig. 4 b.

Fig. 4 a and b. Right knee of same patient as fig. 1 after 3 months of immobilization in plaster. Films: 6 months after fig. 1.

The tenderness on palpation corresponded in both cases to the regions where radiologic examination showed changes in bone structure, suggesting o. d. or its pre-state, the ossiculum with diminished viability.

Both boys were treated by immobilization in plaster for about 8 weeks, but while in the case of the first it took almost 6 months until the osteochondrotic focus had disappeared (fig. 4.), in the case of the younger, the focus had fused with the epiphysis after only 3 months (fig. 5).

The soundness of healing was proved when the elder boy, about $1^1/_2$ years after treatment, received a heavy blow on the right knee when playing football. At radiologic examinations 4 weeks and 6 months, respectively, after the accident, nothing abnormal could be found and the knee remained free from symptoms (fig. 6). A roentgen examination of the younger boy a year after treatment, revealed a slight flattening of the medial condyle of the femur, but no other abnormality. The irregularities of the medial condyle of the left femur had, as is usual, disappeared spontaneously.

Fig. 5 a. Fig. 5 b.

Fig. 5 a and b. Right knee of same patient as fig. 2 after 8 weeks of immobilization. Films: 3 months after fig. 2.

Fig. 6 a. Fig. 6 b.

Fig. 6 a and b. Right knee of same patient as fig. 1, taken 1½ years after fig. 1 and 4 weeks after a heavy fall on the knee.

Conclusions

A report is given of the development of o. d. in two brothers, the younger presenting the pre-state of o. d., the elder a developed form of o. d. of the right knee. The left knee — free from symptoms — of the younger boy showed radiologic signs of ossicula about to unite with the epiphysis, at the same relative position as the pathologic focus could be seen in his right knee. This, together with the elder brother's developed o. d. strongly supports RIBBING's thesis that the condition arises from the accessory osseous nuclei of the epiphyses. Having found an anatomic substratum which makes it possible to observe the development of o. d., we should be able to prevent it, probably in all cases, which give early symptoms, and cure it relatively quickly by immobilization.

The value of a conservative attitude in the treatment of this disease has lately been pointed out by WIBERG.

The observations described in this and my preceding paper on o. d., should be especially important to those who examine children regularly at schools and are concerned with the supervision of sports activities of youth. Symptoms at this age are often very slight, and young people should be watched rather carefully in order that preventive treatment may be commenced in time. The question arises as to whether the knees, at least, of children and adults going in for hard physical training, should not be examined radiologically as a preliminary routine measure.

In both boys the focus of o. d. disappeared after immobilization in plaster; in the elder after about 6 months and in the younger (with the pre-state of o. d.) after about 3 months. That seems to be a shorter time than the average published in the literature for most of the cases of spontaneous healings of o. d. The advantage lies in minimizing the danger of loose bodies developing and shortening the precautionary period during which the patient is partially unfit just at an age when the body's activity is naturally very intensive.

SUMMARY

Two brothers with osteochondrosis dissecans of the knee-joint were treated conservatively by immobilization in plaster. The changes, observed by repeated roentgen examinations, subsided, resulting in complete restitution in a relatively short time. The findings strongly support RIBBING's thesis on the cause of osteochondrosis dissecans.

ZUSAMMENFASSUNG

Zwei Brüder mit Osteochondrosis dissecans des Kniegelenkes wurden konservativ mit Immobilisierung durch Gipsverband behandelt. Die Veränderungen, die durch wiederholte Röntgenuntersuchungen beobachtet wurden, bildeten sich zurück und verschwanden innerhalb verhältnismässig kurzer Zeit völlig. Diese Befunde bekräften nachdrücklich RIBBING's These über die Entstehung der Osteochondrosis dissecans.

RÉSUMÉ

Deux frères atteints d'ostéochondrose disséquante du genou furent traités de manière conservative par l'immobilisation dans le plâtre. Les lésions observées au cours d'examens radiologiques répétés s'atténuèrent jusqu'à guérison complète, et ce, dans un laps de temps relativement court. Ces faits sont tous en faveur de la thèse de RIBBING sur les causes de l'ostéochondrose disséquante.

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BOOK REVIEWS

THE NORMAL CEREBRAL ANGIOGRAM. By Arthur Ecker. 190 pages, 140 illustrations. Charles C. Thomas, Springfield, Ill., 1950. $ 6.50.

The technique employed is described in detail. As a rule, percutaneous puncture of the common carotid artery is performed, 15 cc of 35 % diodrast being injected for each series of films (one arteriogram and one phlebogram). A 5 % dextrose solution is introduced from a Murphy drip apparatus between the injections. Stereoscopic A. P., lateral and occipital views are obtained as a routine measure, the tube for the latter being tilted 30 degrees cranially. The lateral views are taken with a vertical beam projection and rotation of the head. In special cases, the routine films are supplemented with axial (submento-vertical), facial (with the chin elevated) and optic foramen views. Up to 200 cc of diodrast has been injected at one examination without any serious ill-effects. For vertebral angiography, the author employs either direct percutaneous puncture of the vertebral artery or indirect filling by injection of the common carotid artery with simultaneous compression of the carotid artery above the needle and of the brachial artery. No figures are given as to how often satisfactory contrast filling has been obtained.

The normal anatomy is described for each projection separately. This method may be useful for those who are not used to interpreting radiologic examinations. It is, however, only of limited value to the neuroradiologist who has to combine the various views into »a picture in space».

Lastly the vascular relations of the tentorial notch and foramen magnum are discussed. The author claims that it should be possible to recognise transtentorial herniation from displacement of the vessels especially of the anterior choroidal and posterior cerebral arteries. A coning through the foramen should also be demonstrable from displacement of the inferior cerebellar artery. In the opinion of the reviewer, the films which are intended to show this are not very convincing.

As the author himself says, the book appears to be of value mainly for beginners in angiography. Some of the subjects may however also interest the more experienced neuroradiologist. This is especially true for some of the details of technique and for the last chapter on the vascular relations of the tentorium and foramen magnum.

I. Wickbom.

DIAGNOSTIC ENCÉPHALOGRAPHIQUE. Par Pierre Duran. En collaboration avec H. Garnung et R. Coirault. 192 pages, 26 figures. G. Doin & Cie, Éditeurs, Paris 1951. Frs. 1,100: —.

The technique used by the author is described and briefly consists in the injection of 80—120 cc of air after which A. P. films are taken in the prone and supine positions; lateral films with a vertical beam projection only are obtained. No exposures are made during the injection to demonstrate the fourth ventricle and the aqueduct; these are said to be but seldom visible. Complications even of a minor nature are discussed and the normal anatomy and physiology are briefly described. Certain cases of epilepsy, general paralysis, disseminated sclerosis as well as posttraumatic, infectious and toxic diseases are presented; space-filling lesions are not dealt with at all. Changes in the C. S. F. are described in a special chapter and the therapeutic effect of encephalography is pointed out.

The technique used does not appear to give an accurate picture of the true anatomy and the newer views on encephalographic technique seem to be quite unknown to the author: partly due to this, the conclusions drawn are often not based on real facts. In the opinion of the reviewer, the book does not contribute to our knowledge of the anatomy of normal or pathologic conditions. *I. Wickbom.*

THE CLINICAL USE OF RADIOACTIVE ISOTOPES. By Betram V. A. Low-Beer. Charles C. Thomas, Springfield, Ill., 1950. $ 9.50.

The object of the book is to make the reader acquainted with the clinical applications so far made of the available artificial isotopes. It consists of two parts. The first consisting of 130 pages very briefly presents the necessary physical data so that the matter that follows may be understood. The second — clinical applications — comprises a diagnostic section, clinical investigations with radioactive isotopes covering 137 pages, a chapter of 16 pages on doses and units and a therapeutic section of 66 pages. The book also contains a detailed bibliography, descriptive diagrams and tables.

In the first part of the work, the author gives a short and concise account of the physical nature of the atom according to the newer theories and founded on a more mathematical conception than Bohr's atom model. Mass and weight and charge relations of atoms are defined and the various types of nuclear reactions described. The author writes a binuclear reaction in the following way: $A + a \rightarrow B + b$, where A is an atomic nucleus met by a particle *a* and with it reacts to form a new nucleus B and a new particle *b*. It may be said in passing that the more usual way of writing this would be: A (a, b) B. Furthermore, it is more general to write the mass number above and to the left of the symbol of the element (as recommended by the International Union of Chemistry). As many others, the author puts it on the right of the symbol used. Having described the laws of natural decay, the author proceeds to give methods of detection and measurement of radioactivity. He describes radioautographic technique, the methods of ionization measurement, the Geiger-Müller counter method as well as the errors and limitations of measurements and the correction factors. The information should be sufficient for test analysis for measuring the half-life or for the determination of relative quantities but hardly for carrying out absolute measurements of radioisotopes. The physical part is concluded with a short chapter on radioactivity units and standards in which, among others, the curie, the rutherford, the roentgen, rep and rem are described. There is also an equally short chapter on safeguards against hazards in the use of radioisotopes.

The clinical part deals with the radioactive isotopes of phosphorus, sodium, strontium, iron, manganese, iodine, yttrium and cobalt — mostly used up to now in clinical medicine. A pervading feature is the author's description of the methods of producing radioactive isotopes which are described with special consideration to target material, nuclear reaction and separation technique. Maybe, however, this account will be of less interest to the medical man and does not appear to be sufficiently detailed for the nuclear chemist.

The beginning of the second part of the work is devoted to the diagnostic use of isotopes. The uptake and excretion of the different radioisotopes is clarified by tables and curves and the biological effect on normal and pathologic tissue is described. The methods of determination of blood volume and red blood cell volume by radiophosphorus and radioiron as well as of determining the circulation time by radiophosphorus and radiosodium, are described in detail. The author also details the tracing of radiophosphorus by surface measurements, the biological effects of beta-radiation and the preparation of radiophosphorus in colloidal solution. The determination of the extra-cellular fluid volume with ^{24}Na after trauma and shock as well as changes in the circulation in vascular

diseases are described; the latter are illustrated by 'build-up' curves. Experiences gained up to now with radioiodine are clearly and relatively fully summarized. The different methods of determining thyroid function are mentioned but for detailed technique the reader will have to look up the works listed in the bibliography. The uptake of radioiodine in thyroid tumours is mentioned as well as the transport of radioiodine from mother to fetus. The author touches briefly on the possibility of the localization of tumours of the brain with radioactive diiodofluorescin. Finally, he discusses the diagnostic possibilities with the radioactive isotopes of strontium, calcium, arsenic, mercury, manganese, gold and zinc, the last three in the form of colloidal solutions.

Before the author proceeds to the therapeutic part, he includes a short chapter on dosage determinations with radioisotopes. The therapeutic part first deals with radiophosphorus. The author gives a detailed account of his own 'saturation methods' especially in the treatment of leukaemias; these are based upon fractional treatment: ^{32}P in small doses at frequent intervals is considerably more highly retained by the body than radiophosphorus in large single doses. Intravenous injection forms the method of administration. However, the author gives no account of the results gained by other authors with large single doses per os and consequently the reader cannot compare the value of the two methods. Typical cases of acute and chronic leukaemia, polycythaemia vera, Hodgkin's disease, lymphosarcomatosis, mycosis fungoides, multiple myelomatosis and metastases from breast carcinoma, more or less successfully influenced by radiophosphorus, are described. Examples are also given of superficial therapy with radiophosphorus in skin diseases. The therapeutic value of radiosodium is briefly touched upon and the effect of radioiodine more fully presented, especially in hyperthyroidism. Carcinoma of the thyroid and its metastases are summarily discussed as is the employment of radiocobalt as a substitute for radium.

Final assessment: a well-written, informative book for medical students and physicians.

Magnus Strandqvist.

LÉSIONS NOUVELLES DU POIGNET. PSEUDOKYSTES NÉCROBIOTIQUES. KYSTES PAR HERNIATIONS CAPSULAIRES. ARTHRITE CHRONIQUE DÉGÉNERATIVE PAR OSTÉOCHONDROSE MARGINALE. Par Jean-Pierre Bugnion. 123 pp, 44 illustrations. Suppl. 90. Acta radiol. Stockholm 1951. Sw. Kr. 20: —.

Cysts of the wrist-bones are extremely frequent. A statistical study of 600 roentgenograms (300 autopsies) revealed lacunae in more than half of the cases. The cysts are usually bilateral; they show no preference for the right side or for either sex. The incidence is independent of occupations; a traumatic origin can therefore be excluded. The frequency and extent of the lesions increase moderately with age, reaching a maximum between 61 and 70 years. The capitate and lunate bones are most often affected.

Histologic examinations show three new forms of carpal lesions:

1) *The ischemic non-traumatic pseudocyst* is due to a central or marginal progressive liponecrosis. This cyst may reach a diameter of 10 mm. It develops by reason of vascular disturbances and is seen mainly in the aged.

2) Cysts which develop as a result of *the herniation of the synovial membrane* into the bone along the insertion of ligaments and penetration of blood vessels. The diameter of these cysts is not larger than 2 or 3 mm. They are found mostly in young subjects. Sometimes signs of resorption and organisation may appear.

3) *Laminar marginal osteochondrosis* (RUTISHAUSER): selective lesions of the skeleton, appearing as an ankylosing arthritis. It may complicate necrobiotic cysts and synovial herniations. This last type is extremely important as it leads to a complete ankylosis which differs histologically from the one produced by rheumatoid arthritis.

Autoreview.

HIRNDURCHBLUTUNGSSTÖRUNGEN. IHRE KLINIK UND ARTERIOGRAPHISCHE DIAGNOSE. Von A. Brobeil. 264 Seiten, 84 Abb. Georg Thieme Verlag, Stuttgart 1950. DM 45. —.

The author considers angiography to be an inseparable diagnostic aid in diseases of the cerebral vessels. His aim in disturbances of the cerebral system is to place the angiographic beside the patho-physiologic and clinical pictures The book deals predominately with patho-physiologic, patho-anatomic and clinical questions and these parts can be warmly recommended. The roentgenologic section consists, apart from illustrations to the case reports, of a few pages only. For the technique of the examination the reader is referred by the author to an earlier work. A more detailed account of roentgenologic differential diagnosis is lacking. The author issues a warning, it is true, on accepting unsatisfactory films but appears to have hardly avoided this danger himself. The technical factors which govern the appearances of a given film do not seem to have been taken sufficiently into consideration. Objective information which is necessary in order to convince the reader that the author's interpretation of his films is correct is to a certain extent missing. The roentgenologic part of the work accordingly does not stand on the same level as the remainder.

S. E. Sjögren.

MEMORANDUM ON GAMMA-RAY SOURCES FOR RADIOGRAPHY. The Institute of Physics, London, 1952. 23 pages. 3 s. 6 d.

A short review of various radiographic sources obtainable from the Atomic Energy Research Establishment, Harwell, and the Radiochemical Centre, Amersham. Data on the properties of the radioactive substances in question, the construction and prices of the sources, advice on protection and photographic exposure graphs are included.

Sven Benner.

CORRIGENDUM

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A GRID IONIZATION CHAMBER OF SPECIAL DESIGN FOR THE MEASUREMENT OF SOFT RADIATIONS

by

A. Somerwil

(Vol. 36, Fasc. 1)

The last line before the Summary on page 47 should read as follows: Maximum total error 2.2 %.

NOTICE

A David Anderson-Berry Silver-gilt medal, together with a sum of money amounting to about £ 100, will be awarded in 1953 by the Royal Society of Edinburgh to the person, who, in the opinion of the Council, has recently produced the best work on the therapeutical effect of roentgen rays on human diseases.

Applications for this prize are invited. They may be based on both published and unpublished work and should be accompanied by copies of relevant papers.

Applications must be in the hands of the General Secretary, Royal Society of Edinburgh, 22 George Street, Edinburgh, 2, by *March 31st, 1953.*